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ROYAL SOCIETY OF ARTS

JOURNAL

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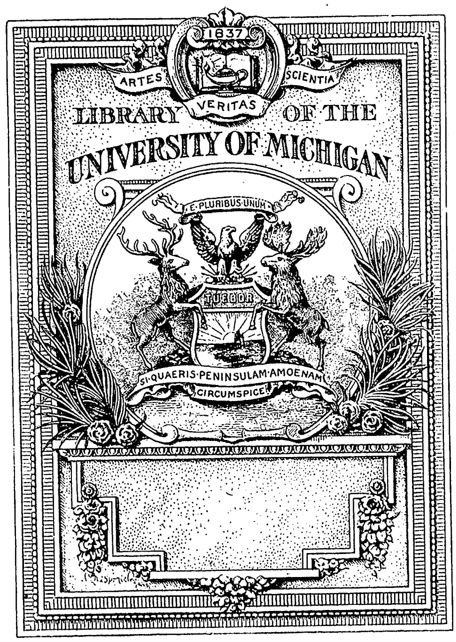

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JOURNAL

OF THE

ROYAL

SOCIETY OF ARTS

VOLUME LX.

FROM NOVEMBER 17, 1911, TO NOVEMBER 15, 1912.

LONDON:

PUBLISHED FOR THE SOCIETY BY GEORGE BELL & SONS, LTD.,
YORK HOUSE, PORTUGAL STREET, LINCOLN'S INN FIELDS, W.C.

1912.

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LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
DUKE STREET, STAMFORD STREET, S.E., AND GREAT WINDMILL STREET, W.

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Journal of the Royal Society of Arts.

No. 3,078. VOL. LX.

FRIDAY, NOVEMBER 17, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

ONE-HUNDRED-AND-FIFTY-EIGHTH SESSION, 1911-1912.

PATRON—HIS MAJESTY THE KING.

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SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One Hundred and Fifty-Eighth Session was held on Wednesday evening, November 15th, when an address was delivered by LORD SANDERSON, G.C.B., K.C.M.G., Vice-President and Chairman of the Council. (See pp. 6–15, below.)

PAPERS TO BE READ BEFORE CHRISTMAS.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 22.—JAMES DOUGLAS, LL.D., Past President of the American Institute of Mining Engineers, "The Industrial Progress of the United States of America." The Right Hon. Sir HENRY MORTIMER DURAND, G.C.M.G., K.C.S.I., K.C.I.E., late H.B.M. Ambassador at Washington, will preside.

,, 29.—A. E. BERRIMAN, "The Efficiency of the Aeroplane."

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DECEMBER 6.—J. A. J. DE VILLIERS, Hon. Secretary of the Hakluyt Society, "British Guiana and its Founder, Storm van 's Gravesande." LORD REAY, G.C.S.I., G.C.I.E., LL.D., will preside.

" 13.—W. YORATH LEWIS, Mem.Am.Soc.M.E., A.M.Inst.Mech.E., A.M.I.E.E., "Continuous Service in Passenger Transportation."

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 14.—J. TRAVERS JENKINS, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal."

PAPERS TO BE READ AFTER CHRISTMAS.

CECIL THOMAS, "Gem Engraving."

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

FRANK WARNER, "Silk."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

CYRIL DAVENPORT, "Illuminated MSS."

ERNEST KILBURN SCOTT, A.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

PROFESSOR G. W. OSBORN HOWE, "Recent Progress in Radio-Telegraphy."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Stage Illusion."

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

WALTER SAISE, D.Sc., M.Inst.C.E., F.G.S., "The Coal Industry and Collier Population of Bengal."

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

ALAN BURGOYNE, M.P., "Colonial Vine Culture."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 18, February 8, March 14, April 25, May 16.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 30, February 27, March 26, May 7.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

PROFESSOR VIVIAN B. LEWES, "The Carbonisation of Coal." Four Lectures.
November 27, December 4, 11, 18.

LECTURE I.—NOVEMBER 27.—*The Composition of Coal.* Existing theories on the composition of coal and the chemistry of its formation—Humus and resin compounds found in lignites, and the action of heat upon them—The classification of coals, and the effect of composition on the products of decomposition by heat—Coking and non-coking coals.

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LECTURE II.—DECEMBER 4.—*The Methods Employed in the Destructive Distillation of Coal.* The changes which have taken place during the last century in the forms and settings of gas retorts—The developments of the last ten years and present position of the gas industry—The coke industry and the gradual development of the modern recovery plant—The influence of the retort or oven on the carbonisation.

LECTURE III.—DECEMBER 11.—*The Thermal Conditions existing during the Carbonisation of Coal.* The heat of formation of coal—The work of Euchene, Mahler, and others—The cause of the endothermic nature of some coals—The thermal value of the reactions taking place in the retort—The losses of heat in a retort setting—The transmission of heat through the retort and charge—The effect of temperature and travel on the primary products of decomposition—The temperatures existing in retorts and ovens—Small charges and full charges—The influences which lead to improvement in the product from full charges, chamber and vertical retorts.

LECTURE IV.—DECEMBER 18.—*The Possible Improvements in Carbonisation.* The aims of the gas manager and coke producer—Experiments on low temperature distillation and their teaching—The rivalry existing between fully-charged retorts, vertical retorts, recovery ovens, and chamber carbonisation—The intermittent vertical retort *versus* the continuous vertical systems—The Settle-Padfield, Duckham-Woodall, and Glover-West processes—The ideals of carbonisation—The volume of gas due to primary and secondary reactions—The gasification of tar—The limitations of volume and quality of gas—The ends to keep in view in devising new processes of carbonisation.

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." Two Lectures.
January 22, 29.

LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." Three Lectures.
February 5, 12, 19.

LUTHER HOOPER, "Hand-Loom Weaving." Three Lectures.
February 26, March, 4, 11.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.
March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.
April 29, May 6, 13, 20.

JUVENILE LECTURES.

Wednesday afternoons, at 5 o'clock:—

CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." Two Lectures.
January 3 and 10, 1912.

CONVERSAZIONE.

The Annual Conversazione of the Society will be held about the middle of June, 1912. Each member is entitled to a card for himself, and one for a lady.

PROCEEDINGS OF THE SOCIETY.

THE SOCIETY was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom: and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country." In 1908 the Society was granted by King Edward VII. the privilege of adding "Royal" to its title.

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The Session commences in November and ends in June.

Ordinary Meetings.—Meetings are held every Wednesday evening during the Session, at which papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

Indian Section.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

Colonial Section.—This Section was formed in 1874 under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged in 1879, so as to include the consideration of subjects connected with our Colonies and Dependencies. Four or more Meetings are held during the Session.

Cantor Lectures.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. Several Courses are given during the Session, each Course consisting of two or more Lectures. The Lectures deal with the latest applications of Science and Art to practical purposes, and are, as far as possible, experimentally illustrated.

Howard Lectures.—The bequest of Mr. Thomas Howard (1872) is now devoted to occasional courses of Lectures on motive power and its applications.

Shaw Lectures.—Under the Shaw bequest Lectures on Industrial Hygiene are given from time to time.

Aldred Lecture.—The bequest of the late Dr. Aldred has been devoted to the establishment of an Annual Lecture.

Cobb Lectures.—Funds have been provided for an occasional Lecture in memory of the late Mr. Francis Cobb.

Juvenile Lectures.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the children of Members during the Christmas holidays.

Admission to Meetings.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted by signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

Journal of the Royal Society of Arts.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures and Commerce.

Examinations.—Examinations, founded in 1853, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal elements of Commercial Education and Music. At the 1911 Examinations 28,644 Candidates were examined, at 459 centres. Full particulars of the Examinations can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

Conversazioni are held, to which Members are invited, each Member receiving a card for himself and a lady.

Membership.—Candidates for Membership are proposed by Three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election or a Life Subscription of Twenty Guineas may be paid. There is no Entrance Fee

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CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1911–1912. It is issued subject to any necessary alterations:—

NOVEMBER, 1911			*DECEMBER, 1911*			*JANUARY, 1912*			*FEBRUARY, 1912*		
1	W		1	F		1	M		1	Th	
2	Th		2	S		2	Tu		2	F	
3	F		3	**S**		3	W	Juvenile Lecture I.	3	S	
4	S		4	M	Cantor Lecture I. 2	4	Th		4	**S**	
5	**S**		5	Tu		5	F		5	M	Cantor Lecture III. 1
6	M		6	W	Ordinary Meeting	6	S		6	Tu	
7	Tu		7	Th		7	**S**		7	W	Ordinary Meeting
8	W		8	F		8	M		8	Th	Indian Section
9	Th		9	S		9	Tu		9	F	
10	F		10	**S**		10	W	Juvenile Lecture II.	10	S	
11	S		11	M	Cantor Lecture I. 3	11	Th		11	**S**	
12	**S**		12	Tu		12	F		12	M	Cantor Lecture III. 2
13	M		13	W	Ordinary Meeting	13	S		13	Tu	
14	Tu		14	Th	Indian Section	14	**S**		14	W	Ordinary Meeting
15	W	Opening Meeting of the Session	15	F		15	M		15	Th	
16	Th		16	S		16	Tu		16	F	
17	F		17	**S**		17	W	Ordinary Meeting	17	S	
18	S		18	M	Cantor Lecture I. 4	18	Th	Indian Section	18	**S**	
19	**S**		19	Tu		19	F		19	M	Cantor Lecture III. 3
20	M		20	W		20	S		20	Tu	
21	Tu		21	Th		21	**S**		21	W	Ordinary Meeting
22	W	Ordinary Meeting	22	F		22	M	Cantor Lecture II. 1	22	Th	
23	Th		23	S		23	Tu		23	F	
24	F		24	**S**		24	W	Ordinary Meeting	24	S	
25	S		25	M	Christmas Day	25	Th		25	**S**	
26	**S**		26	Tu	*Bank Holiday*	26	F		26	M	Cantor Lecture IV. 1
27	M	Cantor Lecture I. 1	27	W		27	S		27	Tu	Colonial Section
28	Tu		28	Th		28	**S**		28	W	Ordinary Meeting
29	W	Ordinary Meeting	29	F		29	M	Cantor Lecture II. 2	29	Th	
30	Th		30	S		30	Tu	Colonial Section			
			31	**S**		31	W	Ordinary Meeting			

MARCH, 1912			*APRIL, 1912*			*MAY, 1912*			*JUNE, 1912*		
1	F		1	M	Cantor Lecture V. 3	1	W	Ordinary Meeting	1	S	
2	S		2	Tu		2	Th		2	**S**	
3	**S**		3	W		3	F		3	M	
4	M	Cantor Lecture IV. 2	4	Th		4	S		4	Tu	
5	Tu		5	F	Good Friday	5	**S**		5	W	
6	W	Ordinary Meeting	6	S		6	M	Howard Lecture 2	6	Th	
7	Th		7	**S**	Easter Sunday	7	Tu	Colonial Section	7	F	
8	F		8	M	*Bank Holiday*	8	W	Ordinary Meeting	8	S	
9	S		9	Tu		9	Th		9	**S**	
10	**S**		10	W		10	F		10	M	
11	M	Cantor Lecture IV. 3	11	Th		11	S		11	Tu	
12	Tu		12	F		12	**S**		12	W	
13	W	Ordinary Meeting	13	S		13	M	Howard Lecture 3	13	Th	
14	Th	Indian Section	14	**S**		14	Tu		14	F	
15	F		15	M		15	W	Ordinary Meeting	15	S	
16	S		16	Tu		16	Th	Indian Section	16	**S**	
17	**S**		17	W	Ordinary Meeting	17	F		17	M	
18	M	Cantor Lecture V. 1	18	Th		18	S		18	Tu	
19	Tu		19	F		19	**S**		19	W	Conversazione
20	W	Ordinary Meeting	20	S		20	M	Howard Lecture 4	20	Th	
21	Th		21	**S**		21	Tu		21	F	
22	F		22	M		22	W	Ordinary Meeting	22	S	
23	S		23	Tu		23	Th		23	**S**	
24	**S**		24	W	Ordinary Meeting	24	F		24	M	
25	M	Cantor Lecture V. 2	25	Th	Indian Section	25	S		25	Tu	
26	Tu	Colonial Section	26	F		26	**S**	Whit Sunday	26	W	Annual General Meeting
27	W	Ordinary Meeting	27	S		27	M	*Bank Holiday*	27	Th	
28	Th		28	**S**		28	Tu		28	F	
29	F		29	M	Howard Lecture 1	29	W		29	S	
30	S		30	Tu		30	Th		30	S	
31	**S**					31	F				

The Cantor Lectures will commence at Eight o'clock.

The Ordinary Meetings will commence at Eight o'clock.

The Meetings of the Indian Section and the Colonial Section will be held at Half-past Four o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Five o'clock.

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PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 15th, 1911; LORD SANDERSON, G.C.B., K.C.M.G., Vice-President and Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Angel, Robert John, M.Inst.C.E., A.R.I.B.A., Town Hall, Spa-road, S.E.

Baildon, Arthur Edward, Yeo Cottage, 6, Yeo-street, Yeoville, Johannesburg, South Africa.

Bain, Professor Samuel M., University of Tennessee, Knoxville, Tennessee, U.S.A.

Banganapalle, The Nawab of (Nawab Saiyid Ghulam Ali Khan Bahadur), Banganapalle, India.

Beanes, Fred. E. V., 4, Morden-road, Blackheath, S.E.

Benson, His Honour Judge William Denman, 10, William-street, Lowndes-square, S.W.

Bhattacharya, Professor Saratchandra, M.A., F.C.S., St. Columba's College, Hazaribagh, Bengal, India.

Black, Professor Ebenezer Charles, LL.D., 50, Kirkland-street, Boston, Mass., U.S.A.

Bray, Henry Freer, 2, Kasumi-cho, Azabu, Tokyo, Japan.

Bremner, Alexander, 38, New Broad-street, E.C.

Bright, Alfred Ernest, 34, Queen-street, Melbourne, Australia.

Burnside, William, Assoc.M.Inst.C.E., c/o Messrs. MacBride, McGrouther & Co., 149, West George-street, Glasgow.

Butcher, Miss Anna Deane, c/o Dr. Bailey, Featherstone Hall, Southall, Middlesex.

Canjee, Sheriff D., 13, Cuffe-parade, Bombay, India.

Cantlie, James, M.A., M.B., F.R.C.S., D.P.H., 140, Harley-street, W.

Chowdhury, Brajendra Kishore Roy, Gouripore, Mymensingh, India.

Clare, George Herbert, P.O. Box 1194, Saskatoon, Saskatchewan, Canada.

Cocks, Robert Macfarlane, 24, Oakwood-court, Kensington, W.

Coen, Giorgio Silvio, San Polo, Palasso Bernardo 1978, Venice, Italy.

Cole, Harold Linter, c/o Messrs. King, King & Co., Bombay, India.

Corfe, Right Rev. Bishop Charles John, D.D., Church House, Dean's Yard, Westminster, S.W.

Cross, Malcolm, 1, Devonshire-gardens, Glasgow, W., and Carlton House, 11D, Regent-street, W.

Daniel, Captain F., Penang Pilot Association, Government Buildings, Penang, Straits Settlements.

Datta, Aswini Kumar, Barisal, Eastern Bengal and Assam, India.

Dickson, Charles Allan, Kadarma, E.I.R., India.

Douglas, Greville, 27, Wilton-crescent, S.W.

Dukoff-Gordon, Ronald, B.A., Germiston, Transvaal, South Africa.

Dutt, Ajit Kumar, Dilkusha, Bhowanipore, Calcutta, India.

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Ellahie, Abdur Raheen Buksh, 10, Colootolah-street, Calcutta, India.

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Fletcher, A. Byers, D.D.S., 9, Park Mansions, Knightsbridge, S.W.

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Hamilton, Professor George Hall, B.A., 12, Grove End-road, St. John's-wood, N.W.; and Bellevue College, Bellevue, Nebraska, U.S.A.

Hate, Professor Vinayak Nanabhai, B.Sc., Girgaon Back-road, Girgaon, Bombay, India.

Hewlett, William George, Box 3492, Johannesburg, South Africa.

Jackson, B. Leslie, A.R.C.A., Croft Lodge, The Park, Newark-on-Trent.

Jameson, Percy R., Taylor Instrument Company, Rochester, New York, U.S.A.

Jhaveri, Krishnalal Mohanlal, Girgaon Post Office, Bombay, India.

Lloyd, Charles Sidney FitzRoy, Custom House, Shanghai, China.

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Misra, Syama Behari, B.A., Jodhpur, India.

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Morrill, George Pillsbury, Ph.B., M.Am.Soc.C.E., Sagua la Grande, Cuba.

Mottram, Arthur H., Tin Areas of Nigeria Co., Limited, P.O. Naraguta, Bauchi, N. Nigeria, West Africa.

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Nilambur, The Raja of, Nilambur, Malabar, India.

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Pillai, P. Kesava Pillai Padmanabha, Trivandrum Travancore, India.

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Standen, Bertram Prior, C.I.E., I.C.S., The Holt, Chorley Wood, Herts, and Nagpur, Central Provinces, India.
Stewart, Arthur James, 41-45, Mutual Buildings, Johannesburg, South Africa.
Stikeman, Hon. William R., Messrs. Gillanders, Arbuthnot & Co., Rangoon, Burma.
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Thomas, William, M.Inst.M.E., Glanffrwd House, Cemetery-road, Porth, Glamorgan.
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Turner, Captain Frederick Arthur, 73, Drewstead-road, Streatham Hill, S.W.
Venning, Captain Francis Esmond Wingate, Pyawbwe, Upper Burma.
Watson, Francis Dashwood, 62, Upper Richmond-road, Putney, S.W.
Watt, James, 24, Rothesay-terrace, Edinburgh.
White, Henry E., Dunedin, New Zealand.
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The Chairman delivered the following

ADDRESS.

I must begin by expressing my sense of the honour which my colleagues on the Council have done me in electing me to be their Chairman for the current year. I cannot refrain from adding an expression of my gratitude to Edward Henry, fifteenth Earl of Derby, a former Vice-President, who, knowing my propensity for science—and being desirous, as he said, of making an additional donation to the funds of the Society—proposed me thirty-two years ago for membership, and paid my life subscription. It was one of many acts of generous kindness for which I was indebted to him, and has procured me many hours of instruction from the Society's publications, though circumstances over which I had no control have prevented me from being a frequent attendant at its meetings.

There are one or two events which ought to be noticed at the beginning of our Session, though they have already found mention in the Council's reports. I have to congratulate the Society on the acceptance of the office of President by H.R.H. the Duke of Connaught. During the course of the summer his Royal Highness was good enough to show his interest in our proceedings by personally presenting to Sir Charles Parsons the Albert Medal of the Society which had been awarded to him. I think you will agree with me that our best thanks are due to Lord Alverstone for his acceptance and tenure of the office of provisional President during the interval of vacancy caused by the King's accession to the Throne. It has been a fresh instance of the efficient and valuable support which the Society receives from Lord Alverstone.

I have also to congratulate the Society on the completion of its new medal, bearing the effigy of King George. The portrait is a remarkable success, and has received his Majesty's gracious commendation.

Finally, I cannot omit to call attention to the five most interesting papers on the early history of the Society which have been contributed by our Secretary to its *Journal*. If for no other reason, I should prize them as explaining the meaning of the remarkable pictures which adorn our walls, and which have hitherto, I confess, been to me an object of admiring bewilderment.

I was in some perplexity as to the choice of a subject for the address which it is customary for the Chairman of Council to deliver at the opening of the Session. I found that my predecessors, as seems right and reasonable, had selected for their topics some branch of industry, art, or applied science, of which, in the course of their respective professions, they had been in a position to acquire intimate knowledge, and on which they could therefore speak with authority. But diplomacy, in the study and practice of which I have passed my life, though it is sometimes termed an art, can scarcely be included in the Arts which this Society was formed to encourage. Nor could I claim your attention for a disquisition on the methods of framing Protocols or on the cultivation of the very essential quality of holding one's tongue. I have thought, however, that it might not be uninteresting or unprofitable to examine briefly what is one of the most striking features of recent years—the immense development of international intercourse. It is a vast subject, on which a volume could easily be written, and with which I can only deal in a cursory and fragmentary manner. I do not think that many of us realise how much it enters into our daily lives. As Rousseau said, "It requires much philosophy to observe what happens every day."

And I should like to preface any attempt at systematic discussion of the subject by relating two somewhat trivial incidents which brought the matter home to me.

The first happened some four or five years ago. I was travelling on the Highland Railway in Sutherlandshire, and the train stopped for eight or ten minutes at a not very important station, in the manner with which travellers on that line are familiar, while the two engines went off to get a drink of water, and a sort of garden party took place on the platform. Just as the engines were returning refreshed, a young man advanced towards my carriage who appeared to be the embodiment of national industry and sport. He was dressed from head to foot in dark grey homespun; he carried in one hand what was obviously a rifle case, in the other he had a caddy-bag full of golf clubs, on his back were strapped a fishing-rod and gaff, at his side was a large fishing basket, round his waist was a long steel chain, at the other end of which was a magnificent retriever. A porter opened the door, the dog jumped in and at once lay down under the seat, his master got in after him and sat down with a thump, and all his accoutrements clattered round him. Then it occurred to him that he was not provided with luncheon. He took out sixpence, beckoned to a boy and bought a bunch of bananas. Those bananas had come from the West Indies, some five thousand miles away. I contrasted with this the doleful account given twenty years ago by a Roumanian gentleman of his travels in North Britain, how he had suffered the extremities of hunger, had rushed to a refreshment stall and taken away a small pie, and how on opening it he had found that it contained nothing but a bit of pig's ear, and I realised what improved communications had done for us.

The second incident occurred this summer. I was distributing to various friends a small book of children's stories, weighing just under eight ounces. The heat was so great that I preferred to send a copy by post to Belgrave Square instead of taking it myself. The postage cost twopence. I wished also to send copies to Denmark, Russia, and Japan. The charge for doing so was equally twopence, and if I had wished to send one to Timbuctoo, where not long ago Cassowaries were supposed to eat missionaries, with hymn-book sauce, but where there is now a regular French administration, the cost would still, I believe, have been twopence.

To turn to the wider aspects of the question, I will begin with that with which I am best acquainted, but which is not after all the most important—the growth of diplomatic intercourse. I am not going to drag you into an archæological dissertation, but it may be interesting to glance for one moment at the records which we have of such intercourse some 3,500 years ago. You will find in the Babylonian and Assyrian Room of the British Museum a whole series of small clay tablets, containing the instructions issued by Khammurabi, King of Babylon, about 2,000 years B.C., to his administrative officers in the provinces and cities under his rule, and in another case are preserved portions of a correspondence which took place some five hundred years later between Amenophis III., King of Egypt, and Kallimma Sin, King of Karaduniyash in Babylonia. It seems that Amenophis had married a sister of Kallimma-Sin, and was now making proposals of marriage for one of his daughters, named "the Little One," or, I suppose, "Tiny." The nature of Kallimma-Sin's reply may be gathered from the label attached to a further letter from Amenophis, of which Dr. Budge, the eminent head of the department, has kindly given me a copy.

"After salutations Amenophis refers to the refusal of Kallimma-Sin to give him his daughter in marriage, on the grounds that she is too young and is not beautiful, and in answer to Kallimma-Sin's complaint—that no one knows what had become of his sister, who had married Amenophis, or whether she was alive or dead—he invites him to send a wise man to see her and to report upon her health, the comfort in which she lives, and the honour in which she is held. If Kallimma-Sin will give Amenophis another daughter to wife, he will send him richer gifts than any prince of Karaduniyash could afford to give him. Finally, Amenophis expresses a wish that friendship may continue to exist between himself and Kallimma-Sin, and begs him not to believe the words of the Mesopotamian envoys, who have declared that they received no gifts from the King of Egypt, and in the matter of the chariots and horses, which Kallimma-Sin has asked to be returned to him, he declares that though they may have reached the frontier of Egypt, they have never entered the country."

In another portion of the correspondence, preserved in the Museum at Berlin, Kallimma-Sin claims matrimonial reciprocity, that Amenophis should send him an Egyptian princess to wife. Amenophis replies, with hauteur, that

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it has not been the custom that princesses of Egypt should marry anybody or nobody. The unabashed Kallimma-Sin returns to the charge.

"Why not?" he writes. "Thou art King, and canst do as thou pleasest, and if thou shalt give her unto me, who shall say a word against it? Surely there be beautiful women in Egypt, and if thou knowest any such, send her to me—for who could say here that she is not a princess?"

I must not detain you longer over ancient history, in which I fear I am not a very competent guide, and will leap like a grasshopper over an interval of 3,000 years to the fifteenth century of the Christian era, when the maintenance of permanent diplomatic agents at foreign Courts, initiated some time previously by the Popes, became general in Europe, simultaneously with the establishment of permanent armies. Some cynical writers on international law have drawn the conclusion that these permanent missions were kept up quite as much for the purpose of watching the military progress of the various states, as for the maintenance of good relations. Certainly the ambassadors were not always very convenient guests. There is in the State Papers of Henry VIII. an elaborate account, sent to the European Governments, of the manner in which it was discovered that the Austrian Ambassador was intriguing for the overthrow of Wolsey, and a justification of the demand made for his recall. It would seem that a messenger charged with the Ambassador's despatches was found wandering about on his way to the ship that was waiting for him in the Thames, in a manner which suggests a London fog, and that, being unable to give an intelligible account of himself, he was arrested and his packets opened, in which such horrible things were discovered that they were at once sent to the Lords of the Privy Council. The Papal Legate succeeded in getting hold of and carrying off Henry VIII.'s love letters to Anne Boleyn, and they are now in the Vatican Library. In the reign of Queen Elizabeth, the Spanish Ambassador was sent back on a charge of conspiracy against the Queen's life, and in that of Charles II. a conflict took place between the French and Spanish Ambassadors as to the right of precedence in going to Court, in which shots were freely exchanged, five or six people were killed and thirty wounded.

The presence of a Russian Ambassador at the Court of Queen Anne is made memorable by the demand of Peter the Great for the heads of the sheriff's officers who arrested him for debt, and by the presentation in lieu thereof of the statute on diplomatic immunities, enclosed in a gold box.

Although Turkey was not formally admitted into the concert of European nations until the Congress of Paris in 1856, we had a British Ambassador resident at Constantinople as early as 1621. The first permanent Turkish envoy in London arrived in 1795.

The story of the progress of international relations with China and Japan is full of interest, but I can only briefly allude to one or two episodes. In 1793 Lord Macartney was sent on a special mission to the Emperor of China, and successfully evaded the demand that, on being admitted to the Imperial presence, he should perform the kotow, by offering to do so if a high Chinese official would go through the same ceremony before a picture of George III. The result was that he was allowed to kneel on one knee in the manner obtaining at the English Court. But the Chinese Court records omitted all mention of this modification, and when Lord Amherst was sent on a similar mission in 1816, the demand for the performance of the kotow was renewed. As Lord Amherst persistently refused, he was sent back without an audience, the Prince Regent's letter was returned unopened, with most of the presents, and a letter was addressed to the King of England by the Emperor giving his account of the circumstances in a tone which throughout assumes that the embassy was one from a subordinate Sovereign, and charged with tributary offerings. It is too long to quote, but the sting is in the tail, which is as follows:—

"The Celestial Empire does not value things brought from a distance. All the extraordinary and ingenious productions of your country also it does not look upon as rare pearls.

"That you, O King, should preserve your people in peace, and be attentive to strengthen the limits of your territory, that no separation of that which is distant from that which is near should take place, is what I, the Emperor, in truth highly commend.

"Hereafter there is no occasion for you to send an Ambassador so far, and to be at the trouble of passing over mountains and crossing seas. If you can but pour out the heart in dutiful obedience, it is not necessary at stated times to come to Court, e'er it be pronounced that you turn towards the transforming influences which emanate from this land.

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"This Imperial mandate is now given that you may for ever obey it."

Thenceforth, it may be said in general terms that when our envoys went on special missions to Pekin, they usually did so with an expeditionary force at their backs, until the establishment there of a resident Minister in the person of Sir Frederick Bruce in 1860. The first regularly accredited Chinese Minister, Kwo Tajen, came here in 1877. Almost immediately after his arrival he was entertained at a large dinner party at the Foreign Office. I sat close to him, and I still have a vivid recollection of the expression of his face as he chewed and swallowed a large piece of lemon which had been handed to him to squeeze into his turtle soup. He remarked very courteously, when I explained his mistake, that it was not the best thing he had eaten since his arrival in England.

Our first permanent envoy to Japan was appointed in 1859, and the first Japanese Minister was received here in 1875. I remember the arrival of a previous Special Mission in 1867, escorting a young brother of the then reigning Tycoon — an intelligent, attractive boy. I was present at their interview with Lord Stanley, then Foreign Secretary. The conversation turned on the fire which destroyed His Majesty's Opera House in the Haymarket, and which the Mission had seen from the windows of their hotel. The Tycoon's brother made an observation which elicited a general laugh from his suite and which was interpreted, "He says, my Lord, that they have a fire as big as that in Japan nearly every day."

As regards the increase in the amount of business transacted by the Foreign Office, my statistics go back no further than 1826, but they are sufficiently remarkable. The total number of despatches received and sent in the year at that period averaged 11,000. It steadily increased to 30,000 in 1849. After an abnormal increase during the Crimean War, it steadied down to 50,000 in 1860. It was over 70,000 in 1880, and in 1900 it stood at 100,000—since which there has been a further gradual increase.

I reserve to the conclusion of my address a remarkable feature of recent diplomatic intercourse in which the Society has been more actively interested. In the meanwhile, let us turn to other matters in which it has taken a not unimportant part.

And first, as regards the growth of our postal communications with foreign countries and the oversea parts of the Empire. In 1619 a separate office of Postmaster-General of England for foreign parts was created by letters patent in favour of a certain Matthew de Quester and his son, who in 1633 transferred it to William Frizell and Thomas Witherings. The latter appears to have been the first of our postal reformers, and entered into a contract with the Count of Turn and Taxis, hereditary Postmaster of the Empire and of Spain, for the acceleration of the Continental mail service. There was at that time only one mail weekly between London and the Continent, *via* Antwerp and Brussels, and the transit occupied from four to five days. By a subsequent contract two mails weekly were secured, and the transit made ordinarily in two days. In 1819 there were still but two mails a week to the Continent *via* Calais, Ostend, or Helvoetsluys on Tuesday and Friday; to Portugal once a week only from Falmouth; to the Mediterranean, the West Indies, and South America once a month, also from Falmouth.

I have seen somewhere an enthusiastic description of the seven fine cutter-rigged packet-boats kept at Dover for the service across the Channel. No use was made of steam navigation for the packet service till 1821.

Contrast this state of things with the present organisation in which the Post Office issues in October a long table of the dates at which letters and packets should be posted in order to reach the most distant parts of the globe by Christmas and New Year's Day, and when, as I have told you, a small book-packet can be sent almost everywhere short of the moon for the same charge as to another part of London.

Statistics on such subjects run into such stupendous figures that they produce a feeling of bewilderment. The weight of correspondence in letters, postcards, printed and commercial papers and samples, exchanged by the United Kingdom with foreign countries and British colonies during the year 1910, is given in the last report of the Postmaster-General as eleven and a half millions of pounds avoirdupois, and the number of parcels as over five millions.

On the subject of the development of telegraphic communication, and of the part taken in it by the Society, you had an address last year from my predecessor, and I will not venture to intrude on the domain in which he has ruled supreme. I will only quote to you an instance of the effect it has had in facilitating international commercial transactions which is given by Mr. Wells in his book on "Recent Economic

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Changes." It happened in 1884. An eminent merchant of Boston, before starting with Mr. Wells on a journey from New York to Washington, telegraphed to his agent in Calcutta to buy hides and gunny bags if procurable at a certain price, and to charter a ship for their conveyance if one could be found. On his arrival at Washington, a telegram from the agent was put into his hands stating that the goods had been purchased, the vessel chartered, and that loading had begun.

I believe that nowadays, by means of what are profanely called Macaroni-grams, such transactions can be commenced and completed in the course of a five days' passage across the Atlantic.

It may, perhaps, amuse you to hear of the struggles which we made at the Foreign Office to keep down the expenditure in telegrams, which rose from £3,000 in 1869–70 to £20,000 in 1879–80; and in 1900–1, owing to adverse circumstances, reached a maximum of £55,000. Since then it has been considerably reduced, partly, no doubt, in consequence of the lower rates of charge, partly because our Agents have acquired the art of condensing. It takes some time, as the late Lord Salisbury said, to learn to write Telegraphese, and some people cannot acquire the art. I was a good deal relieved to find at our worst moment that the expenditure of the Japanese Government under this head was so much greater, that our charge appeared a mere flea-bite in comparison.

As regards facilities for travel by sea, you need only read Charles Dickens' account of his fifteen days' passage on the mail steamer to Halifax in 1842, and compare it with the voyages now made by the huge floating palaces which run to New York.

The contrast is perhaps even more remarkable on land. Gibbon relates in the second chapter of his great work, that the chain of roads in the time of the Roman Empire reached from York to Jerusalem through Rome and Constantinople —a distance of 3,740 English miles, broken only by two short sea passages from Sandwich to Boulogne, from Brindisi to Durazzo—that post-houses were established at intervals of five or six miles and constantly provided with forty horses, and that by means of these relays it was easy to travel a hundred miles a day. Julius Cæsar has the reputation of having achieved something not far short of this. But the ordinary rate of travel scarcely exceeded twenty to thirty miles a day, and after the break-up of the Roman Empire no such continuous journey was possible. In 1834, Sir James Hudson, travelling night and day with the summons from King William IV. to Sir Robert Peel to form a Government, accomplished the journey from London to Rome in nine days. Sir Robert and his family, travelling, as Mr. Justin McCarthy remarks, from Rome to London in exactly the same way as Constantine had travelled from York to Rome 1,500 years before, reached their destination in twelve days, having halted on four nights only, because they could not get on. The time now allowed for the journey is under forty-eight hours.

It is calculated that in 1840 there were in Europe and America only 5,000 miles of railway in operation. In 1885, the number of miles was probably about 300,000; it is estimated as amounting in 1906 to 578,000 miles.

On the growth of commercial intercourse, I have some very convincing statistics to offer you. In 1906 a paper was laid before Parliament giving the total value of imports and exports for eleven principal European countries and the United States in 1854, and every succeeding tenth year down to 1904, and my friends at the Foreign Office, who are always kind to me, have added the figures for Italy and for the year 1910. I will be merciful to you, and leave you to study this paper as an appendix to my address in the *Journal*. I am not concerned with odious comparisons as to the rates of increase in different countries, it is sufficient for me that that increase is general, and I will only tell you that the net imports of the United Kingdom have risen in value from £134,000,000 in 1854 to £575,000,000 in 1910, and the exports from £97,000,000 to £430,000,000, an increase of over 300 per cent. in each case, while the population has increased by about 70 per cent. only.

As an indication of the increased comfort which this progress has brought with it, it is interesting to notice that the imports of butter have risen in value from £15,000,000 in 1896 to £24,500,000 in 1910, and of eggs from £4,000,000 to £7,000,000. Or, if you prefer the quantities, the amount of imported butter retained for use in the United Kingdom has risen from 3,000,000 cwts. to 4,500,000 cwts., and the number of eggs from 1,000 millions to 2,000 millions.

I come finally to what seems to me the most notable feature of recent international intercourse, and that in which this Society is most interested—the great increase in international

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FOREIGN TRADE (COMPARATIVE GROWTH).

Total Imports and Exports (Special Trade) for each of the years 1854, 1864, 1874, 1884, 1894, 1904, and 1910 (so far as the information can be given), of the following thirteen Countries, viz.:—1. France; 2. German Zollverein and German Empire; 3. Belgium; 4. Netherlands; 5. Russia; 6. Austria-Hungary; 7. Denmark; 8. Sweden and Norway; 9. Spain; 10. Portugal; 11. United States; 12. United Kingdom; 13. Italy.

(A.)—IMPORTS OF MERCHANDISE.

Countries.	1854.	1864.	1874.	1884.	1894.	1904.	1910.
	£	£	£	£	£	£	£
France	46,320,000	101,128,000	140,308,000	173,740,000	154,016,000	180,092,000	270,392,000
German Zollverein and German Empire	No returns of values available in these years		177,231,000	160,323,000	193,633,000	312,420,000 [8]	439,260,000 [8]
Belgium	13,737,000	27,555,000	51,699,000	57,030,000	62,982,000	111,289,000	170,598,000
Netherlands	18,983,000	30,796,000	54,284,000	92,720,000	120,598,000	200,188,000	271,603,000
Russia	11,140,000	25,843,000	74,635,000	53,797,000	55,957,000	68,759,000	*95,669,000* [9]
Austria-Hungary	21,226,000 [2]	25,482,000 [2]	56,870,000	51,052,000	58,333,000	85,329,000	118,869,000
Denmark	The real values of imports cannot be given in these years		11,656,000	13,656,000	17,056,000	25,873,000	*31,488,000* [9]
Sweden (General Trade)	*3,341,000*	*5,293,000*	*16,515,000*	*17,791,000*	*19,163,000*	*31,778,000*	*34,200,000* [9]
Norway	No returns of values available	5,752,000 [4]	10,115,000	8,672,000	11,001,000	15,014,000	*19,830,000* [9]
Spain (General Trade)[1]	*8,137,000*	*16,601,000*	*20,350,000*	*29,379,000*	*31,185,000*	*37,793,000*	*43,990,000*
Portugal	2,586,000 [3]	5,585,000 [5]	6,015,000	7,325,000	8,025,000	13,960,000	*14,571,000* [10]
United States (years ended June 30th)	57,518,000	62,732,000	118,217,000	139,078,000	132,628,000	204,546,000	322,314,000
United Kingdom (Net Imports)	133,943,000	222,781,000	311,991,000	327,076,000	350,565,000	480,734,000	574,496,000
Italy	No returns available	39,345,000 [6]	51,826,000	52,790,000 [7]	43,786,000 [7]	76,549,000 [7]	128,188,000 [7]

Note.—Special Imports are Imports for Home Consumption. In the cases of Sweden and Spain the figures given as "General Imports" include, besides the imports for home consumption, a certain quantity of merchandise subsequently re-exported.

1 Particulars of the "Special" Imports of Spain are not available before 1888. The "Special" Imports amounted to £30,149,000 in 1894, to £36,423,000 in 1904, and to £39,814,000 in 1910.

2 Including Venetia and Mantua.

3 In 1851. The value of Bullion and Specie is included.

4 In 1866, the first year for which returns of Special Trade are available.

5 In 1865. Returns of Special Trade for the year 1864 are not available.

6 Excluding Venetia, Roma, and part of Mautua.

7 Including Silver Bullion.

8 Including the value of the Improvement Trade for Home Account (£4,912,000), and also the value of ships (£535,000). These items have only been included in the German returns of Special Trade since 1897.

9 In 1909, the latest year available.

10 Provisional figure. In 1909, the latest year available.

(B.)—EXPORTS OF MERCHANDISE.

Countries.	1854.	1864.	1874.	1884.	1894	1904.	1910.
	£	£	£	£	£	£	£
France	50,444,000	116,968,000	148,044,000	129,300,000	123,124,000	178,040,000	240,228,000
German Zollverein and German Empire	No returns of values available in these years		115,694,000	157,574,000	145,607,000	256,778,000 [8]	367,506,000 [8]
Belgium	15,561,000	23,876,000	44,586,000	53,499,000	52,147,000	87,330,000	136,297,000
Netherlands	14,794,000	25,776,000	42,248,000	69,847,000	92,708,000	165,255,000	218,403,000
Russia	10,345,000	28,526,000	68,370,000	58,990,000	66,875,000	106,229,000	*150,699,000* [10]
Austria-Hungary	22,104,000 [2]	32,341,000 [2]	44,927,000	57,625,000	66,290,000	87,028,000	100,775,000
Denmark	The real values of exports cannot be given in these years		8,682,000	8,333,000	12,317,000	19,924,000	*24,657,000* [10]
Sweden (General Trade)	*4,228,000*	*5,220,000*	*12,501,000*	*13,255,000*	*16,580,000*	*23,040,000*	*26,277,000* [10]
Norway	No returns of values available	3,798,000 [4]	6,527,000	6,088,000	6,891,000	9,495,000	*13,036,000* [10]
Spain (General Trade)[1]	*9,935,000*	*12,182,000*	*18,400,000*	*24,672,000*	*26,772,000*	*37,208,000*	*42,425,000*
Portugal	1,886,000 [3]	4,524,000 [5]	5,149,000	4,853,000	5,383,000	6,910,000	*6,968,000* [11]
United States (years ended June 30th)	44,860,000	29,896,000	118,632,000	151,034,000	181,084,000	298,996,000	256,268,000
United Kingdom	97,185,000	160,449,000	239,558,000	233,025,000	216,006,000	300,711,000 [9]	430,385,000 [9]
Italy	No returns available	22,931,000 [6]	39,128,000	42,842,000 [7]	41,060,000 [7]	63,889,000 [7]	80,331,000 [7]

NOTE.—Special Exports are Exports of Domestic Produce or Manufacture. In the cases of Sweden and Spain the figures given as "General Exports" include, besides the exports of domestic merchandise, a certain quantity of foreign merchandise previously imported.

1 Particulars of the "Special" Exports of Spain are not available before 1888. The "Special" Exports amounted to £25,137,000 in 1894, to £35,640,000 in 1904, and to £38,234,000 in 1910.

2 Including Venetia and Mantua.

3 In 1851. The value of Bullion and Specie is included.

4 In 1866, the first year for which Returns of Special Trade are available.

5 In 1865. Returns of Special Trade for the year 1864 are not available.

6 Excluding Venetia, Roma, and part of Mantua.

7 Including Silver Bullion.

8 Including the value of the Improvement Trade for Home Account (£5,013,000), and also the value of ships (£520,000). These items have only been included in the German Returns of Special Trade since 1897.

9 Including the value of ships and boats (new) with their machinery exported, which amounted to £4,455,000 in 1904, and to £8,770,000 in 1910. These items have only been included in the Trade Returns of the United Kingdom since 1899.

10 In 1909, the latest year available.

11 Provisional figure. In 1909, the latest year available.

exhibitions, associations and conferences of every description, and on every conceivable subject. When I first joined the Foreign Office, rather more than fifty years ago, conferences were confined almost entirely to formal diplomatic meetings to settle some urgent territorial or political question in which several States were interested. At rare intervals, and on some occasion of paramount importance, a congress was held, the name implying that, instead of sending ordinary plenipotentiaries, the States concerned were represented by their Foreign Ministers or persons of equal standing. Of these latter only one, the Congress of Berlin, has been held during my period of service. But as time has gone on, not only have the number and frequency of political conferences increased, but a host of meetings of personages more or less official, termed indiscriminately conferences and congresses, have come into being. The International Exhibition of 1851 was so great an event that there was an inclination on the part of many sanguine people to believe that it would inaugurate an era of universal peace. That illusion was speedily dispelled, but international exhibitions were repeated at regular and stated intervals. Then came a sudden boom in exhibitions, and now it seems to me that there is always an international exhibition of something going on somewhere. The last variety that has come into notice is an International Field Sports and Shooting Exhibition, held at Vienna in 1910, of which a report has just been laid before Parliament.

These exhibitions seem to breed congresses. At the Paris Exhibition of 1900, an official list was presented of no less than 105 international congresses which it was proposed to hold on various subjects. Actuarial matters, aeronautics, agriculture, Alpinism, anthropology, societies for the blind, botany, bakery, chemistry, railways, popular credit, dentistry, maritime law, electricity, rights of women, geography, geology, head the alphabetical French list—you will not ask me to complete it.

There are certain official international conferences which meet regularly at stated intervals, among the most important of which are that for the revision of the Geneva Convention for the Care of the Sick and Wounded in War, that for the discussion of the arrangements respecting bounties on sugar, those on postal arrangements, telegraphs, wireless telegraphy, the North Sea fisheries. There is a permanent international tribunal at the Hague, ready at any time to hear and decide international disputes, and there are permanent international bureaux on agriculture, copyright, geodesy, health, industrial property, maritime slave trade, the metric system, navigation, the North Sea fisheries investigation, posts, railways, telegraphs, sugar bounties, sleeping sickness, and customs tariffs, to all of which the British Government contributes.

How different is this from the view of Cicero that the southern zone bore absolutely no relation to the condition of Europe, that even Europe had very little interest in the eyes of the humane world of Italy, that it was unimaginable that even the mightiest name from lands of civilisation and culture should pass the eternal barriers of Caucasus or be wafted over the Ganges.

How antagonistic to the spirit of the Turkish Cadi, who wrote to Sir Henry Layard in reply to a request for statistics, "My illustrious Friend and Joy of my Liver, the thing that thou askest is both difficult and useless," and added, "Of a truth thou hast spoken many words and there is no harm done, for the speaker is one and the listener is another. After the fashion of thy people thou hast wandered from one place to another, until thou art happy and contented in none. We (praise be to God) were born here and never desire to quit it. Is it possible then that the idea of a general intercourse between mankind should make any impression on our understanding? God forbid!"

The movement is, to put it shortly, a general tendency to resort to combination—to combined action—as a supplement to and, in some cases, as a substitute for competition. How far the process can be carried without impeding instead of promoting our advance, is one of the problems with which this age has to deal. It seems to be a law of nature that progress should be the outcome of unrest, of the production of an infinite variety of types in an infinite diversity of circumstances, and the survival of those which best bear the test. We can interfere to mitigate the harshness of the operation of the law of nature, but we cannot alter the law itself.

In science, international co-operation has already done much to extend our sphere of knowledge, especially in astronomy, meteorology, and the various questions connected with the conformation and behaviour of the crust o the earth. The charting of the heavens has been apportioned among the observatories of the world. I believe the Greenwich Observatory

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has been commissioned in some special way to keep an eye on the moon, and the tremendous compliment has been paid to us of adopting the Greenwich meridian as the basis of all nautical calculations. Nations have combined to measure degrees of longitude, no comet or astronomical phenomenon is discovered, no earthquake can occur without being the subject of concurrent observation in the most distant parts of the globe. Our knowledge of nature becomes daily wider and more accurate. But the highest mysteries still remain insoluble. Finiteness and Infinity, and, with all due deference to Sir Oliver Lodge, the Ether of Space, remain as inconceivable as ever. We cannot loose the bands of Orion nor bind the sweet influences of the Pleiades.

Politically, the occasions for international disputes have perhaps increased. I have sometimes been appalled to find how no change can take place even in the remotest regions without some British toe being trodden on. But international dependence undoubtedly exercises an increasingly deterrent effect on the tendency to push such differences to extremes, or to resort to the arbitrament of war. I do not yet see the time when wars will altogether cease. That would imply that nations, which are but congregations of individuals, would cease to lose their tempers, and human nature does not change so quickly. But the times of the Truce of God, when fighting was strictly prohibited between Saturday evening and Monday morning, so that the general public might at least have a peaceful week-end—the later age, when, as Bacon puts it, "a just and honourable war" was regarded as "the true exercise of a Kingdom or Estate," when there was almost always a war going on somewhere in Europe to which a young man of spirit could go to win his spurs—these have passed away. War has come to be regarded more and more as a calamity to be avoided, whenever there is any alternative which both parties can reasonably accept.

Socially, it may be said that a general community of interest has come to be recognised throughout the world, that no serious trouble can occur anywhere without efforts being made to relieve it, and that the means of relief are far more efficient than hitherto. This improvement is indeed sometimes a little too evident to persons of moderate means, for no earthquake, famine or pestilence can take place in the outskirts of the habitable globe for which one does not receive an appeal for charitable contributions.

Finally, as regards the intellectual and moral result of our progress, I do not think it can be said that keener intellects, greater wisdom, or more exalted characters can be found in recent times than antiquity has produced. But surely we can claim that the great mass of population in civilised countries are leading, I will not say happier lives—for the elements and conditions of human happiness seem to me an enigma—but lives in the average healthier, longer, more free from hardship, more intelligent and more refined. Our high-water mark remains stationary, but we may hope that the low-water mark tends constantly to rise.

Such, as it seems to me, are the aims and results of work in which this Society has taken a not unimportant share. It has tugged for many years at the labouring oar, it has now the full tide with it. It has still, I feel sure, a useful and honourable part to play, but if I may venture to make a suggestion, I should say that our future work will lie less in the province of stimulation than in the exercise of discrimination and guidance—in pointing out the soundest methods, and selecting the most promising subjects. For this task, with its Committees of Indian and Colonial experts, the Society is very well equipped. We have ample scope, but we must avoid, in the American phrase, spreading ourselves out too thin.

I will ask permission to add one word of apology. I have been begged by one of my colleagues not to omit an exhortation to members to attend our meetings, to bring friends, and to enlist recruits, of which the Society is in constant need. I thought the best method of introducing such a request was to make my discourse as entertaining as lay within my power, and if some portions of it have seemed rather discursive and trivial, you must attribute this failing to my desire to enliven it.

After delivering the Address, the Chairman presented the medals awarded by the Society during last Session.

FOTHERGILL MEDALS (for Mine Rescue Apparatus).

A gold medal to Mr. H. A. FLEUSS, for the apparatus submitted by Messrs. Siebe, Gorman & Co.

A gold medal to Mr. W. E. GARFORTH, in recognition of his efforts to perfect and to secure the adoption of rescue apparatus in mines.

A silver medal for the "Meco" apparatus submitted by the Mining Engineering Company.

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MEDALS FOR PAPERS.

At the Ordinary Meetings:—

To Mr. CAMPBELL P. OGILVIE, "Argentina from a British Point of View."

To Mr. VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "The Panama Canal in 1910."

To Mr. REGINALD A. SMITH, B.A., F.S.A., "A New View of Roman London."

To Mr. PHILIP JOSEPH HARTOG, M.A., B.Sc., "Examinations and their Bearing on National Efficiency."

To Mr. GEORGE A. STEPHEN, "Modern Machine Bookbinding."

To Dr. LEONARD HILL, F.R.S., "Caisson Sickness and Compressed Air."

To Mr. JAMES CANTLIE, M.A., M.B., C.M., F.R.C.S., D.P.H., "Plague and its Spread."

To Mr. GEORGE B. HEMING, "Art Education in the Jewelry, Goldsmithing and Allied Trades."

To Professor RAOUL PICTET, "Les Basses Températures."

To Mr. FRANK M. ANDREWS, "Architecture in America."

In the Indian Section:—

To Mr. ROBERT FELLOWES CHISHOLM, F.R.I.B.A., F.S.A., "The Taj Mahal and its Relation to Indian Architecture."

To Mr. REGINALD MURRAY, "Banking in India."

To Mr. CLAUDE HAMILTON ARCHER HILL, I.C.S., C.S.I., C.I.E., "Education in India."

To Sir THOMAS HENRY HOLLAND, K.C.I.E., D.Sc., F.R.S., "The Trend of Mineral Development in India."

To Mr. W. R. H. MERK, C.S.I., LL.D., "The North-West Frontier Province of India."

In the Colonial Section:–

To Mr. A. MONTGOMERY, M.A., F.G.S., "The Progress and Prospects of Mining in Western Australia."

To Mr. F. DOUGLAS OSBORNE, M.Inst.M.M., "The Tin Resources of the Empire."

To Captain R. MUIRHEAD COLLINS, R.N., C.M.G., "The Commonwealth of Australia."

To Mr. F. WILLIAMS TAYLOR, "Canada and Canadian Banking."

SIR JOHN CAMERON LAMB, C.B., C.M.G., said that as the humble predecessor of Lord Sanderson in the chair, it gave him great pleasure to move a vote of thanks to Lord Sanderson for his address. In the present Chairman the Society not only had a man greatly distinguished in the public service of the country, but it had a working man, one who, before he became Chairman, took great interest in the work of the Society, and showed that interest in a practical way, and who now was conducting the meetings in the most admirable and prosperous manner. He (Sir John) thought all must feel, after hearing the humour which had characterised the address, and the genial way in which he had unbent before them, that Lord Sanderson had contributed very much, when he was in permanent charge of foreign affairs, to the harmony of nations. There was only one thing which he (Sir John) would like to mention, as illustrating the address and the extraordinarily sensitive relations which one part of the world had to another. Last summer he happened to visit an unimportant wireless telegraph station on the coast of Norfolk, and there he heard the Seewarte at Hamburg—the Greenwich Observatory of Germany—giving warning that it was about to distribute German time, and, after a minute or two, at that little place on the Norfolk coast, the Seewarte was heard giving German time. He had the greatest pleasure in moving a very cordial vote of thanks to Lord Sanderson for his charming address.

SIR STEUART COLVIN BAYLEY, G.C.S.I., C.I.E., in seconding the proposition, said he recalled the time when he had deprecated very strongly the custom of the Society requiring its Chairmen of Council to deliver an address as soon as they received the honour of that office. He was bound to add, however, that that was when he himself was Chairman! Now, however, he completely withdrew his objection, and after hearing what Lord Sanderson had been good enough to contribute in his initiatory address, he hoped the rule would remain in force, and that all future Chairmen would give the members an equally pleasant evening. He fully endorsed what Sir John Lamb had said with regard to the advantages the Society would derive from having a Chairman like Lord Sanderson.

The motion was put and carried unanimously.

LORD SANDERSON, in acknowledging the vote, said he would do his best in carrying out the duties of his office, and he only hoped he would not disappoint the members.

AGRICULTURAL WEIGHTS AND MEASURES.

In the course of a paper recently read by Mr. C. Kains-Jackson to the Farmers' Club on "The Metric System as applied to Agriculture," and the subsequent discussion thereon, attention was drawn to some of the anomalies in the systems of weights and measures from which agriculturists in this country suffer. Thus the barn gallon, by which milk is commonly sold, is equal to 2⅛ gallons. The great hundred, which prevails in the egg and timber trades, is 120. In Glasgow the stone is 22½ lbs., the half-pound (as Mr. Kains-Jackson

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suggests) being apparently a bonus to help the Glaswegian to attract custom from Edinburgh, where the stone is 22 lbs. A quarter of linseed from India, if Bombay shipped, is 416 lbs.; if Calcutta shipped, is 410 lbs.; if bought in Mark Lane, it is 496 lbs., but if bought in cargo it is 492 lbs.

As showing the difficulty of seeing at once the respective values of eggs, a case was taken from the weekly returns of the Board of Agriculture: "Best new laid eggs, London, 1*s.* 6*d.* per dozen; Irish "first" eggs, London, 11*s.* 6*d.* per great hundred; French best eggs, London, 12*s.* per great hundred." It requires a mathematical calculation to discover that the prices of these eggs are respectively 1·5*d.*, 1·15*d.*, and 1·2*d.* each.

Some instances of the useless and irritating multiplication of measures were given by Mr. John McLaren of Leeds. "It seems anomalous and ridiculous at this time of day," he said, "that we should be selling wheat in Doncaster by the load, in Cambridge by the coomb, in Newcastle by the boll; that pits should be sunk in Northumberland by the fathom; that wool should be sold in Scotland by the tod, and beet by the Dutch stone . . . I remember when I went to Yorkshire first, I lived in the middle of the clothing district, where everything was spoken of by yards, and if you asked a man how tall his brother was he would tell you he was 'two yards but an inch.'"

Another speaker, Mr. Alfred Blomfield of Halstead, expressed a strong conviction that "there is no body of men anywhere who are so behind the times and so muddled up as regards sale transactions as farmers. Only to-day I have been on Mark Lane and have bought three different cereals. I bought barley at 25*s.* 6*d.* a quarter, I bought maize at 30*s.* 3*d.* a quarter, and I bought gram at 30*s.* 6*d.* a quarter. Can anyone tell me which is the cheapest corn I have bought there to-day? My barley, which I bought at 25*s.* 6*d.*, works out at £7 2*s.* 6*d.* per ton; the maize, which I bought at 30*s.* 3*d.*, works out at £7 1*s.* 3*d.* per ton; whereas the gram, which cost me 30*s.* 6*d.*, works out at £6 15*s.* 6*d.* per ton, so that the one I gave the most for per quarter was the cheapest per ton." Mr. Blomfield also told of an attempt which he himself had made to institute a small measure of reform. For some months he tried to sell his wheat, barley and oats by the hundredweight, but he found the merchants so difficult to deal with that he had to fall back on the old system. "Now," he continued, "we sell our barley at practically per hundredweight. We sell it at 16 stone per sack, which is two hundredweight. Why should we not sell our wheat and beans in the same way? We sell our beans 19 stone per sack, whereas if we buy maize we only get 17 stone 2 lbs., and if you buy from a middleman you probably only get 17 stone. If we sell our milk below standard we are liable to prosecution, but I believe it is considered perfectly legitimate for a man to buy maize at 17 stone 2 lbs., to take 2 lbs. out of the sack and still sell it as if 17 stone per sack were the proper weight." Matters are further complicated by the fact that standards vary in different markets. Thus, when Mr. Blomfield recently bought some seed wheat at Birmingham, he was under the impression that he was buying it at 18 stone. He found out afterwards that, as the weight of the sack was included, he only got 17 stone 10 lbs. Every sack of wheat was thus 4 lbs. short, but as that was the standard at Birmingham he could make no complaint. Other examples were mentioned by other speakers. In Worcestershire plums are sold by the "pot" of 72 lbs., in Middlesex and Kent by the half bushel, which is sometimes 28 lbs. and sometimes 24 lbs. In the case of apples you are supposed to get 40 lbs. to the bushel, but with some kinds you get more and with others less. Lettuces again are sold by the score, but here a score means not 20 but 22.

The whole meeting was very interesting, and illustrated in a remarkable way the incredibly complicated system of our agricultural weights and measures. It may be true that we are not the only nation that labours under disadvantages of this kind—that in Hungary, for instance, the farmer has a big *joch*, which means 3,200 square metres; a little *joch*, which means 2,400 square metres; and a catastral *joch*, which means about 4,000 square metres; and that in Germany the scientifically termed hectare is invariably transformed into the national *morgen;* but it is poor consolation to us to know that other people are suffering, in greater or less degree, from our own complaints. No doubt, the survival of these old-fashioned measures proves that they are for many purposes practically convenient—otherwise they would have vanished long ago; but the farmers present at this meeting seem to have been clearly of opinion that the time has come when some attempt should be made to simplify our system of weights and measures, and although it is notoriously difficult to change customs, however irrational they may be, which have received the sanction of a long tradition, still it should not be beyond the wit of man to discover some means of reforming a system, which must hamper agricultural transactions in a serious and quite unnecessary manner.

HOME INDUSTRIES.

Machinery Exports to the British Dominions.—Remembering how largely Germans control the mining industry in South Africa, it is a little surprising that German exports of machinery to the Union of South Africa are not greater than they are. The total value of the machinery imported by the Union from all sources in 1909 was £2,150,000, and last year £3,761,500. Of this total (for 1910) the United Kingdom supplied 63·9 per cent. and Germany, which came next, only 20·8 per cent., a percentage that would have been considerably less but for the arrangements made with German manufacturers in connection with the

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scheme for the utilisation of the Victoria Falls and other electrical power schemes in the Transvaal. The electrical machinery imported by the Union in 1910 was of the value of £800,000 and it is to be noted that Germany sent by far the larger proportion of it, her figure being £480,000, the United Kingdom coming next with £251,000, and the United States third with £68,500. The British Crown Colonies and Dependencies have an area of over 1,100,000 square miles, and a population of about 33,000,000. Their imports of all kinds of machinery in 1909—the latest year for which the complete returns are available—were valued at £1,123,822, of which £877,229 came from the United Kingdom, 20 per cent. of the remainder coming from foreign countries. Geographical conditions have a good deal to do with foreign competition. For example, in the West Indies the competition is overwhelmingly from the United States, and to Jamaica the United States sent £21,620 worth of all the machinery imported from foreign countries, valued at £22,820. On the other hand, the theory that trade follows the flag is not supported by Mauritius, an island overwhelmingly French, yet taking more machinery from Germany than from France and England put together. In 1909 India took 48 per cent. of the machinery sent by the United Kingdom to the British Dominions overseas, or nearly as much as all the other British possessions put together. Her purchases of machinery of foreign manufacture did not exceed 5 per cent. of the whole. The total value of the machinery imported into India in the year ended March 31st, 1910, was £5,637,823, and of this the machinery of British origin represented £5,301,166, or 94·1 per cent., machinery of other origin £336,657, or 5·9 per cent. only. The chief of our foreign competitors was the United States, which sold India machinery to the value of £136,298, followed by Germany with a value of £71,371, but some of the machinery under the head of the Netherlands, Belgium, and Austria-Hungary was probably German, but even if it were all German only about £46,000 would have to be added to the German total. The present position of the United Kingdom in relation to its exports to British possessions overseas cannot be said to be unsatisfactory.

Short Time in the Cotton Trade.—There is good reason to hope that the conditions of trade will now enable the cotton mills to run full time. A fall of 2½*d.* per lb. means £100,000,000 on the average cotton crop of the world, and must have a very marked effect upon the consumption of manufactured goods and the consequent employment of the mills. Enhancements in the price of the raw material seriously affect all cotton manufacturing centres, but more especially England, owing to her great export trade to the Far East, where the purchasing power of the people is very limited. The other cotton manufacturing centres are engaged mostly in supplying the requirements of their home consumers, whose purchasing power is less restricted. It is noteworthy that of late years, since 1904, when the International Cotton Federation was established, foreign countries have co-operated in the policy of short time as far as their organisations and conditions admit, a policy which, as Sir C. W. Macara demonstrated anew the other day, has averted great disasters. "There is no doubt about this," he said: "if during the recent years of short supplies of cotton we had had unrestricted working, disasters of incalculable magnitude would have befallen the trade. We should have had many more failures or liquidations, and we might have had periods of complete stoppage, during which the sufferings of the workpeople would have been acute."

The Miners' Unrest.—The refusal of the Scottish mineowners to consider the miners' demand for a minimum wage increased the probability of a national stoppage in the coal-fields, but happily the representatives of the coalowners of England and North Wales at the Conciliation Board have since conceded the principle of the minimum wage, and promised to recommend it to their various districts. The Board thereupon adjourned until December 6th, and probably there will be further adjournments and meetings until a settlement is reached. It is true that this only applies to England and North Wales, and there remain South Wales and Scotland, but even there the owners are willing to enter into negotiations for the minimum wage in "abnormal places," and, anyway, the yielding of the owners' representatives in England and North Wales will make a general strike much less likely, and it is the contention of the employers that the men cannot declare an immediate general stoppage without violating their agreements. In the case of the Midlands district, which includes Yorkshire, Lancashire, Cheshire, Derbyshire, Staffordshire, Nottinghamshire, and the Forest of Dean, the conciliation agreement, subject to reservations of a technical nature, can be terminated at three months' notice. In Scotland the existing agreements have another year to run, and in Wales over three years. The contention of the employers is that until these agreements expire no question involving a change in wages can be discussed. This, however, is disputed by the men, who claim that this question of a minimum wage is one outside the scope of existing agreements.

Trailer Tramcars.—Although it is understood that the London County Council intend to apply for Parliamentary powers to attach trailer-cars to their trams, at least in the rush hours, it may be doubted whether, should Parliament consent, these trailers will do much towards solving the traffic problem. Trailers are common on the Continent and in America, but they have not done much towards meeting the rush traffic, and there are various objections to their use. The police do not like them on the ground that they are dangerous and obstruct the streets, dangerous owing to the

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inferior control which generally results, and to the greater risk of injury to passengers boarding or leaving the cars if the driver receives the signal to proceed when only one car is ready to move. Then, the trailer reduces the rapidity of transit so much to be desired during the rush hours, and although it increases the carrying power it reduces the economic value of the tramway. The only real solution of this rush traffic problem would seem to be higher speeds and a more frequent service.

Employers' Liability Insurance Losses.—Figures issued by the Board of Trade, and covering fifty-six insurance companies, show that last year employers' liability business meant heavy loss to these companies. The total premiums earned amounted to £2,272,763; these figures represent the net premiums received during the year, plus the amounts reserved from the preceding year's premiums on account of unexpired liability, less the corresponding amounts reserved in respect of the current year's premiums. Losses are given at £1,649,537, an amount equal to 72·58 per cent. of the premiums; and commissions and expenses together are given at £816,307, which is equivalent to 35·91 per cent. of the premiums. The total loss on trading account for all companies is £193,081, which is equivalent to 8·49 per cent. of the premiums. Thirty-four of the companies included conduct their business on tariff lines, while twenty-two are non-tariff. The premiums earned during the year by the thirty-four tariff companies amounted to £1,985,325, on which a loss of £94,532, or 4·77 per cent. of the premiums, was incurred, and the premiums earned by the twenty-two non-tariff companies amounted to £287,434, in respect of which the loss on the year's trading was £98,549, or 34·28 per cent. of the premiums.

OBITUARY.

ALBERT HARRISON, F.C.S.—Intimation has been received of the death of Mr. Albert Harrison, which took place on August 28th. He was born in 1860, and after being educated at the Liverpool Institute he entered the laboratory of Messrs. Henry Tate and Sons' sugar refinery in Liverpool. In 1878 he was transferred to the London branch, of which he rose to be manager. He was a Fellow of the Chemical Society, a member of the Society of Chemical Industry, and of a large number of other scientific societies. He was well known as an entomologist, and for the statistical accounts of the results of breeding experiments which he conducted with British lepidoptera. He became a member of the Royal Society of Arts in 1886.

MASACHIKA SHIMOSÉ.—Mr. Masachika Shimosé, of Tokyo, died on October 6th, at the age of fifty-two. After graduating at the now defunct Imperial College of Engineering in 1884, Mr. Shimosé spent three years at the Printing Bureau, where he superintended the manufacture of printing ink and pigments. In 1887 he was transferred to the Naval Arsenal. Here he devoted much time to the study of explosives, with the result that in 1893 his new compound was adopted by the Japanese Navy, which gave it the name Shimosé powder. In 1899 the Shimosé Powder Factory was established at Akabane, and he was placed in charge of it. His explosive was employed for the first time in actual fighting during the Russo-Japanese War, where it proved to be extraordinarily effective. For his services in this connection he was twice decorated by the Japanese Government. Mr. Shimosé became a member of the Royal Society of Arts in 1906.

ALBERT CHANCELLOR, J.P.—The death occurred on the 9th inst. of Mr. Albert Chancellor, at the age of sixty-nine. Mr. Chancellor, who was until recently an auctioneer at Richmond, Surrey, was mayor of the borough in 1897 and again in 1902. He was also a Justice of the Peace, and formerly a member of the Surrey County Council. He was at one time Master of the Coachmakers' Company and President of Christ's Hospital Club. Mr. Chancellor became a member of the Royal Society of Arts in 1888, and in 1902 he read before it a paper on "The Origin and History of Carriages."

GENERAL NOTES.

SOYA-BEAN CULTURE IN CEYLON.—The soya bean which has come into prominence recently, owing to its commercial value, has now been successfully experimented with in Ceylon. The Agricultural Society secured a large quantity of seed some time ago from the Far East, and experiments were carried out at the Botanic Gardens at Peradeniya, but the cultivation proved a failure. The secretary of the Ceylon Agricultural Society has now succeeded, however, in turning out a large crop in the Government stock gardens in Colombo, producing two varieties, the Japan (white seed) and the Java (black seed), and seed will, it is said, be shortly available for distribution. It is expected that the cultivation of the soya bean will be taken up largely in Ceylon, for besides its value as an article of food it can be exported to the European and American markets.

MOTOR-BOATS IN ICELAND.—The value of motor power is becoming fully recognised by the fishermen of Iceland, judging from a recent report of the French Consul at Reykjavick. From this it appears that the old-time fishing boat propelled by oars is rapidly being superseded by the motor. The total number of motor-driven fishing boats along the coast of the island is now 410. They are chiefly small craft, of from four to five tons, and are more numerous in the north and north-east part, especially in the districts of Isafjord and Akuzegri. In the Westmann islands alone there are upwards of fifty of these little vessels. They are manned by about 1,000 persons. The Icelanders are setting a

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good example by the interest they are taking in the marine motor, and it will not be long before the oar becomes a thing of the past.

INTERNATIONAL SOCIETY FOR THE PROMOTION OF COMMERCIAL EDUCATION.—The *Journal* of August 18th contained a report of the London meeting of the International Society for the Promotion of Commercial Education, which extended from July 24th to August 12th. From this it was evident that, regarded from the educational point of view, the meeting was remarkably successful. The audited accounts have now been published, and it is pleasant to learn that the financial success of the meeting has also been assured, as the committee are left with a small but satisfactory balance in hand. One of the most gratifying results of the London meeting is a considerable increase in the English list of membership, though the Society still possesses more members in many Continental countries than here. Among the new British life members are Lord Rothschild, Lord Joicey, Sir Edgar Speyer, the Right Hon. Frederick Huth Jackson, the Clothworkers' Company, and the Mercers' Company. The Society will hold its next meeting and course of lectures at Antwerp in the summer of 1912. The Belgian Government makes a large annual grant to the Society's funds, and will give material help in the organisation of the Antwerp course.

OIL FROM GRAPE SEED.—An oil of somewhat similar type to that of the olive may be obtained from the stones or seeds of the grape. During the eighteenth century the manufacture of this oil was an industry of considerable importance in many towns in France, especially at Albi (Department of Tarn). The seeds contain from 15 to 20 per cent. of oil, the manufacture of which, thanks to modern processes, has been revived in Italy during the last two or three years. Grape-seed oil is coming into use for soap making, as well as for lubricating and lighting purposes. It is estimated that from two to three million of quintals of this seed could be supplied annually by France alone, which, if separated from the skins of the grapes, would produce from 300,000 to 450,000 quintals (say 6½ to 10 million gallons) of oil. The value of the residuum after wine-making would be considerably enhanced as a raw material for distillation. The brandy (*eau de vie*) thus obtained would not only be of superior quality, but also free from any disagreeable taste due to the essential oil of the seed.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 20...Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. G. K. Fortescue, "The British Museum Subject-Index."

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. Tempest Anderson, "Volcanic Craters and Explosions."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. H. H. Statham, "Modern French Sculpture."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. H. Beaumont, "Troyes."

TUESDAY, NOVEMBER 21...Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. A. H. Roberts' paper, "The Loch Leven Water-Power Works." 2. Discussion on Mr. F. B. Sonnenschein's paper, "The Hydro-Electric Plant in the British Aluminium Company's Factory at Kinlochleven."

Statistical, at the ROYAL SOCIETY OF ARTS, John-st., Adelphi, W.C., 5 p.m. Mr. R. H. Hooker, "The Course of Prices at Home and Abroad, 1890-1910."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. W. B. Ferguson, "A New Density Meter."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. G. Smith, "The Freshwater Crayfishes of Australia." 2. Mr. F. E. Beddard, "Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. III.—On a New Genus of Tapeworms from the Bustard (*Eupodotis kori*)." 3. Mr. A. E. Cameron, "Structure of the Alimentary Canal of the Stick Insect (*Bacillus rossii* Fabr.), with a Note on the Parthenogenesis of this Species." 4. Mr. G. A. Boulenger, "Some Remarks on the Habits of British Frogs and Toads, with reference to Mr. Cummings's recent communication on 'Distant Orientation in Amphibia.'" 5. Mr. H. B. Preston, "Diagnoses of New Species of Terrestrial and Fluviatile Shells from British and German East Africa." 6. Mr. R. Lydekker, "On the Milk-Dentition of the Ratel."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Mr. E. White, "The 1912 International Horticultural Exhibition."

WEDNESDAY, NOVEMBER 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. J. Douglas, "The Industrial Progress of the United States of America."

Geological, Burlington House, W., 8 p.m.

THURSDAY, NOVEMBER 23...Cyclists' Touring Club, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. R. D. Maddock, "A Cycle Tour in Tyrol and the Dolomite Country."

Anthropological Institute, in the C.S.C. Theatre, Burlington-gardens, W., 8.30 p.m. (Huxley Memorial Lecture.) Professor F. von Luschan, "The Early Inhabitants of Western Asia."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Mr. T. G. Tibbey, "Psychology of Reading."

Economics, London School of, Clare Market, W.C., 6 p.m. Dr. M. R. James, "Mediæval Libraries and their Manuscripts."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. E. Carey, "Breakwater Building."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. H. St. George Gray, "Excavations at the Great Stone Circle of Avebury, N. Wilts."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. R. Rankin, "Automatic Reversible Battery Boosters."

Mining and Metallurgy, Institution of, Burlington House, Piccadilly, W., 8 p.m. Dr. James Douglas, "The Development of the Copper Queen and the Warren Mining District."

Chemical, Burlington House, Piccadilly, W., 8.30 p.m. Berthelot Memorial Lecture by Prof. H. B. Dixon.

Literature, Royal Society of, 20, Hanover-square, W., 2.45 p.m. (The Academic Committee.) Obituary addresses. 1. Dr. G. W. Prothero, on "Sir Alfred Comyn Lyall." 2. Dr. W. J. Courthope, on "Edward Henry Pember."

FRIDAY, NOVEMBER 24...Engineers and Shipbuilders, North-East Coast Institute of, Newcastle-on-Tyne, 7.30 p.m.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, NOVEMBER 25...Engineers and Shipbuilders, North-East Coast Institute of, Newcastle-on-Tyne, 7.30 p.m. (Graduates' Section.) Mr. W. Ayre, "Some Notes on the Strength of Ships."

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Journal of the Royal Society of Arts.

No. 3,079. VOL. LX.

FRIDAY, NOVEMBER 24, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 27th, 8 p.m. (Cantor Lecture.) Professor VIVIAN B. LEWES, "The Carbonisation of Coal." (Lecture I.)

WEDNESDAY, NOVEMBER 29th, 8 p.m. (Ordinary Meeting.) A. E. BERRIMAN, "The Efficiency of the Aeroplane." DUGALD CLERK, F.R.S., will preside.

Further details of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 22nd, 1911; The Right Hon. SIR HENRY MORTIMER DURAND, G.C.M.G., K.C.S.I., K.C.I.E., late H.B.M. Ambassador at Washington, in the chair.

The following candidates were proposed for election as members of the Society:—

Bates, Sir Percy Elly, Bart., Hinderton Hall, Neston, Cheshire.

Johnston, Francis Alexander, 16, Draycott-place, Chelsea, S.W.

Price, Herbert, J.P., Berry-street, Queenstown, Cape Colony, South Africa.

Roy, Charles S., Ph.D., 35, Mary-road, Stechford, Birmingham.

Singleton, Miss Esther, 854, Seventh-avenue, New York City, U.S.A.

Thomas, Cecil, 1, Great Pulteney-street, W.

Walton, Robert, 14, Rue Dieu, Paris, France.

The CHAIRMAN, in introducing the lecturer, said probably all present had heard of Mr. James Douglas and of the munificent donation of £20,000 which he had just made to the McGill University of Montreal.

The paper read was—

THE INDUSTRIAL PROGRESS OF THE UNITED STATES OF AMERICA.

By JAMES DOUGLAS, LL.D.,
Past President of the American Institute of Mining Engineers.

The industrial progress of the United States of America during the half century just past is interesting, not only by reason of the rapid development of the country, but of the forces which have been most active in stimulating it. It really dates from the termination of the Civil War. However baneful the passion which war excites, and deplorable the suffering and loss which it involves, it seems always to precede, and probably is efficient in producing, a period of great national activity, in which the rapid advances in the arts of peace obliterate the ravages of war, and smooth the rancorous feelings it excited. The terrible Civil War, which prostrated the South and strained the resources of the North from 1861 to 1865, certainly had that effect. It not only by force welded the nation into one, but it aroused a spirit of industrial energy, spurred on by generous motives.

Until, and even after, the Civil War was fought out, California and Oregon were isolated, by thousands of miles of almost uninhabited country, from the seat of government and the older States. But a railroad, commenced while the war was raging and finished in 1872, or seven years after the war closed, brought the East and the West into intimate touch, and gave the people some faint conception of the incalculable value of the vast intervening stretches of prairie and mountain and plateau, lying between the Missouri River and the Pacific. Laws were therefore framed with the view of utilising as rapidly as possible these boundless resources. When the vastness of the space to be peopled, and the wealth to be garnered from the soil and from the rocks of

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half a continent, untouched by the hand of man, came to be even dimly realised by the united people, an invitation was given to the whole world, including even the Chinese, bidding all to enter and to help in harvesting the treasures which seemed so boundless. It was a policy instigated, not solely by motives of gain, but by a spirit of generosity and fraternity. These altruistic impulses are stronger in an early stage of a people's organic life than after industrial selfishness and class prejudice have chilled the enthusiasm, still warm, in the new-born nationality. While it is true that the most liberal land laws would not have succeeded in creating a great industrial nation in half a century had the resources to work upon not been present, it is equally true that without the laws and the democratic constitution the resources would have been more slowly developed.

Emigrants from Europe accepted eagerly the hearty invitation to people the West, but the opening of the West diverted the current of the native American population inland, towards the development of its own continental resources. One result has been that, with the accumulation of wealth and the growing sense of power, national ambition has expanded. The absorption of colonial possessions was inevitable. And it must follow that this great country, with its expanding commerce, will intervene, as a world power, in the world's politics. Nations, as they grow, resistlessly break away from restrictions which were wisely recommended and observed at an earlier stage of their development.

Another result of the discovery of the Great West has been that, in diverting American energy inland, it has transferred it from the sea. This influence was probably more effectual, though less conspicuously recognised, in its effect on American commerce, than the destruction of the old mercantile fleet by the "Alabama." The restless human elements of the Atlantic coast had previously gone to sea; but after the discovery of gold in California, and the extension of the railroad westward, the fertile prairie and the Rocky Mountains offered a more attractive outlet for the lover of adventure than the sailor's life, and the West coupled the promises of gain with abundance of danger. Thus, when a sailor became a pioneer, he gratified his impulse to break loose from the rigid confines of family life, the narrow circle of his neighbourhood, and the restrictions, political and social, which he resented in his old home. This temper has always been strong in the English stock, and finds its expression in the constitution of such new States as Oklahoma and such British colonies as New Zealand, where old limitations are removed, to be generally replaced by others as stringent. New England, the nursery of the American mercantile navy, has been deserted by her children. They scattered west, not east—to the temporary detriment of the American marine and American foreign commerce. But it would be a mistake to regard this aberration from racial habits and instincts as otherwise than very temporary. It was, and is, a racial instinct that drives Americans and Canadians to the western wilds, and it is in obedience to a national instinct, dating back to the early colonial days, that the American abhors crowding. The original colonists of Virginia and Massachusetts felt the influence of the unlimited space of an unoccupied continent, and yielded willingly to the reaction against the territorial and social restrictions of the British Isles. They numbered but a few thousand, and yet the shores of Massachusetts Bay and Chesapeke Bay were too narrow for them. They scattered to the north, and south, and west, formed new communities, and won more land from the wilderness. As long as the French hemmed them in between the Alleghanies and the sea, the area of expansion was defined; but once the barrier was broken the race swept westward, and bought or squatted on the land. Individual land-ownership was a legacy from colonial days. Both of the two first groups of colonists who left England in the seventeenth century, those who went to Virginia and those who went to New England, were fellow-partners in a company with English shareholders, one of whose assets was the land they acquired on the American continent. A modified species of communism therefore existed, but only for a very short time. The desire for the private ownership of the land the settlers cultivated was irresistible to men who had lived under the manorial and leasehold systems of Great Britain; and this preference has coincided so accurately with the growth of national prosperity on this side of the Atlantic, that almost all land legislation has favoured actual ownership and small holdings. For a time after the Declaration of Independence the lands of the Western domain were disposed of in large blocks to defray the war debt; but since then legislation has avowedly aimed at frustrating land monopoly and vesting its ownership in the actual cultivator. It has not always succeeded.

The same tendency has controlled the legis-

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lation for the sale of the mineral and forest lands; but in every case a spirit of unbounded liberality in disposing of the public domain has characterised the laws. They were framed to encourage the development of the nation's resources at a time when the vast extent of these resources was not even dreamed of. They have succeeded in effecting the result aimed at to a degree which the law-makers could not possibly have anticipated. Though there can be no doubt that the marvellous development of the country is due to these liberal laws, the present agitation in favour of the reform, in the hope of the conservation of the national resources (though the two reforms are only incidentally related), expresses the general belief that they should have been reconsidered and revised. For while the laws have secured the unfolding and recovery of the national wealth, it is claimed that some of them have been abused so as to encourage the creation of monopolistic trusts. But, in fact, the recent Federal land laws have had very little influence on the materials out of which were created the great Trusts, that of late have attracted so much attention and comment. The iron ores of the Steel Trust in Michigan and Tennessee followed the land, and sugar and tobacco are not primarily Western products. What, however, must be borne in mind, in explanation of the remarkable growth of the country, is that the laws enacted since the war came into operation when the railroad system of the country was being rapidly built up, the steam engine was being improved, and when the means of generating and controlling the electric current were being studied, and when inventors were already conceiving the many industrial uses to which it has since been turned. The country, therefore, sprang into existence, industrially, at the very time these new forces were being brought into the service of man. And no people on the face of the earth were as eager and able to use them as the Americans. From colonial days labour has been scarce and costly; and, therefore, to devise machinery which will replace muscular exertion has become almost a natural and national faculty.

The Disposal of the Western Domain.

At the time of the Declaration of Independence only six of the thirteen States had definite boundaries. They were New Hampshire, Rhode Island, New Jersey, Pennsylvania, Delaware, and Massachusetts. Each of the others laid claim to ill-defined areas of the vast unexplored region west of the Appalachian Mountains. The ownership of these western lands by certain States was opposed by those States which did not share in their possession, mainly on the ground that "the resources of that general government, to which all contributed, should not be taxed for the protection and development of this region, while its advantages would inure to the benefit of the favoured few" ("A Century of Population," p. 19). In 1779, before the war was actually finished, Congress recommended Virginia and the other States to forbear settling or selling their unappropriated lands. All were turned over to the Federal Government except the Connecticut Reservation on Lake Erie, the ownership of which was disposed of by the State of Connecticut, before the jurisdiction over the same was relinquished to the Federal Government in 1800.

The North-west Territory—a still larger domain, some 900 miles by 700 miles—was constituted in 1787 as a single district and subsequently subdivided into five States, designated by number. Even so far-sighted a man as Thomas Jefferson, though under the inspiration of world-building, predicted that "the Western country was so vast and the facilities for transportation and communication so meagre, that it would be a thousand years before the country as far west as the Mississippi would be thickly settled." Facts have contradicted Jefferson's calculations, for the people have succeeded, by liberal legislation, in reducing from ten to one the number of centuries which have expired in filling, though not overcrowding, this vast expanse with an industrious population.

Lands Owned by the Federal Government.

On the creation of the Republic the colonies which became the Thirteen Federated States retained possession of their public lands within their recognised boundaries. But the United States — the Federal Government — retained control of most of its public lands under the constitutions granted by Congress to the States since created by it, and own virtually all the public land in the district of Alaska.*

The present total area of the United States, exclusive of Alaska, is 1,937,144,900 acres (that of Alaska is 378,165,700), but the public lands which passed to the Federal Government originally, and have been since obtained, were 1,441,436,160 acres. The unceded lands in 1904 were 473,836,402 acres; since that date about

* The country's gross area in 1790 was 820,377 square miles; the settled portion 239,935 square miles, or about 29 per cent. ("A Century of Population," a Census Document, p. 17).

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20,000,000 acres have been disposed of, leaving about 450,000,000 acres in the public domain.* Of this the largest quantity is in the arid region, not over 10 per cent. of which can probably be irrigated; but a very much larger proportion is applicable to grazing.

Public lands have been disposed of under the following Acts of Congress passed since the Civil War, and in the following quantities, up to 1909 (Report of the Commissioner of the General Land Office):—

	Acres.
Under the Homestead Act since 1867	115,124,295
Under the Timber and Stone Act since 1878	31,400,133
Under the Desert Land Act since 1877	10,175,006
Under the Timber Culture Act since 1873	5,511,018
Under the Coal Lands Act since 1875	7,675,902
Under State Grants	37,886,678
Under Wagonroad and Railroad Grants	116,875,418
Under State Desert Land Segregations	2,657,489
Under Public and Indian Lands	19,892,503
Unappropriated (disposed of prior to above Acts)	731,354,081
	1,078,552,523

	Acres.
Total area	1,441,436,160
Total disposed of to 1909	1,078,552,523
Undisposed public land	362,883,637

as against 473,826,402 acres unsold in 1904.

A brief summary of some of these laws will explain in part the ease with which wealth has been accumulated, and the rapid strides which industrial progress has made in the United States.

Land Legislation Prior to the Homestead Act of 1862.

The first Homestead Act was passed in 1862, but previous to that date land legislation had occupied much of the attention of Congress. Perhaps the most important measure was the Ordinance of 1787, which guaranteed the absolute ownership of land. But the transfer of its vast domain by the Federal Government to the absolute owners has undergone many changes in both principle and practice.

The United States promised what they did not actually own when, in 1776,† they offered lands in "the western settlements" to deserters from the British ranks, and as a bounty to induce men to enlist in the continental army. But the Federal Government ultimately became owners of these tracts of land west of the Alleghanies, of which certain of the States had become possessors after the expulsion of the French and before the Revolution, and of the still larger north-western domain; with which, according to the Hon. John Jay,* "it may always be remembered to England's credit in the peace negotiations, Shelburne, declining all temptation to a contrary course, endowed the Republic." Mr. Jay describes this as its "gigantic boundaries at the south, west and north, which determined its coming power and influence." When in possession, the Federal Government fulfilled its pledge by rewarding its soldiers by grants of land. It also devoted a liberal portion to education, and sold the balance at $1 an acre in large lots to land companies and individuals, the minimum being an entire section of 640 acres. Land companies were formed to buy tracts by the millions of acres; for the sale of these apparently boundless spaces was regarded as, and really was, the readiest way of relieving the financial stringencies of the Government. Hamilton, as a financier, favoured giving, to the purchaser of one whole township of ten miles square or more, two years' credit, but he also saw the advantage of selling to settlers in small lots. The price of land was soon raised to $2 an acre. And early in the nineteenth century opposition to the disposal of the public domain in large blocks became so strong that the sections that might be sold to a single entryman became smaller and smaller, till in 1820 the present minimum of forty acres (a quarter-quarter section) was reached, and the payment might be made in four instalments. Meanwhile the General Land Office was organised on very much the lines it still possesses. The land debates alternated with settlers' relief debates during the early years of the last century, and stability of legislation was not reached till the Pre-emption Act of 1841 was passed. This was, however, only one of several statutes. The pre-emptor paid the established price, but he bought his acres at private sale, and the Government forfeited the advantage of putting the public domain up in large parcels at public auction. The present pre-emption law permits any authorised purchaser, who does not already own 320 acres, to buy 160 acres, on

* The Report of the Public Land Commissioner (p. xiii.), after giving the figure of 473,836,402 acres unsold in 1904, adds: "The latter figure of nearly a half a billion acres, while but a third of the original area, is still enormous."

† "Land Question in the United States," p. 121, Shosuke Sato, Johns Hopkins University Studies.

* Windsor's "Critical History of America," Vol. V. p. 580.

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which he must reside, and for which he must pay by certain deferred payments. It was the forerunner of the still more liberal system of homesteading, or the free grant of land to actual settlers, which was advocated as early as 1833, and was the object of the "Free Soilers" agitation. (Sato, p. 164.)

The Homestead Act.

The following summary of the homestead law and the method of acquiring land under it is given by Judge Lindley* :—

"The homestead laws secure to the head of a family, of lawful age, who is a citizen of the United States, or who has declared his intention to become such, the right to settle upon, enter, and acquire title to not exceeding one hundred and sixty acres of unappropriated non-mineral public lands, by establishing and maintaining residence thereon, and improving and cultivating the land for the continuous period of five years.

"To obtain an inceptive right to a homestead, the applicant files with the register of the local land office an application, stating his qualifications, and describing the land he desires to enter. If it appears from the tract-books that the land is of the character subject to entry under the law, and is clear—that is, unappropriated—the applicant is permitted to make entry of the land; the receiver of the land office issues a receipt for the fees paid for filing the application, a record is made in the local office, and the fact reported to the general land office. If the lands are returned as mineral, and borne on the tract-books as such, the homestead claimant will not be permitted to initiate his right until a hearing is had for the purpose of determining the character of the land. To use the common expression, the mineral must be 'proved off,' before any right to the land can be inaugurated under the agricultural land laws. Whatever may be the effect of the Surveyor-General's return, as evidence in litigated cases involving the character of the land, the land officers in administering the land laws accept such return as controlling their action in the first instance.

"It would seem that the estate acquired by a homestead claimant who has filed his application and received his preliminary receipt from the receiver of the land office, is of greater dignity than that acquired by filing a declaratory statement under the pre-emption laws. By the preemption laws the United States did not enter into any contract with the settler, or incur any obligation that the land occupied by him should ever be offered for sale. They simply declared that, in case their lands were thrown open for sale, the privilege to purchase should be first given to parties who had settled upon and improved them.

* "A Treatise on the American Laws Relating to Mines and Mineral Lands," Vol. I. pp. 204, 205.

"Public land covered by a pre-emption filing as to which there has been no payment made or final certificate issued, may be appropriated by Congress to public purposes, or otherwise disposed of, without infringing any legal right held by the pre-emptioner.

"In an opinion of Attorney-General McVeagh, given at the request of the Secretary of War, it was stated, that upon the 'entry' by the homestead claimant at the local land office, a right in his favour would seem to attach to the land, which is liable to be defeated only by failure on his part to comply with the requirements of the homestead law in regard to settlement and cultivation; that this right amounts to an equitable interest in the land, subject to the future performance by the settler of certain conditions, and, until forfeited by failure to perform the conditions, it must prevail, not only against individuals, but against the Government; that, in contemplation of the homestead law, the settler acquires an immediate interest in the land, which, for the time being at least, becomes severed from the public domain.

"The land department has invariably acted upon this theory; and the Supreme Court of the United States has given its sanction to the rule that such an entry, so long as it remains subsisting, is such an appropriation of the tract as segregates it from the public domain. Innumerable filings under the pre-emption laws have been accepted for the same tract by the land office; but from the moment a homestead entry is accepted and the preliminary receipt issued, no further applications or filings for the tract are permitted, so long as the entry remains uncancelled.

"Although the land may be, in fact, mineral in character, and a mining claim be located thereon, no application to patent such mining claim will be received by the land officers until a hearing is had to determine the character of the land.

"If the land be found at such hearing to be mineral in character, a cancellation *pro tanto* of the homestead entry will be ordered, and the mineral lands will be segregated, whereupon the mineral applicant may proceed to patent."

Under the Homestead Act there have been 850,728 entries of quarter sections of 160 acres, covering 115,124,295 acres. The size of the entries was therefore about 10 per cent. less than the law allowed. The object of the Act was to settle the land with actual agriculturists, and to discourage its acquisition in large blocks by individuals or corporations. A man, once the patent is issued, can do what he will with his own and dispose of it to corporation promoters, but the patent is only issued to citizens who have nominally lived on the land for five years, or aliens who have declared their intention of becoming citizens. And the same citizen can make only one entry on any class of the public lands.

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Instead of a residence of five years on the land an Act was passed (Sec. 2301 of Revised Statutes, July 1st, 1881), by which, on payment of $2.50 per acre, a patent is issued to the applicant after only fourteen months' residence. Over twenty millions of acres have been purchased under these conditions; but as the Act has been used to facilitate the concentration of land into large holdings, the Commission of 1904 recommended the repeal for the following reason:—

"The object of the homestead law was primarily to give to each citizen, the head of a family, an amount of land up to 160 acres, agricultural in character, so that homes would be created in the wilderness. The commutation clause, added at a later date, was undoubtedly intended to assist the honest settler, but, like many other well-intended acts, its original intent has been gradually perverted, until now it is apparent that a great part of commuted homesteads remain uninhabited. In other words, under the commutation clause the number of patents furnished no index to the number of new homes."

Despite the manifest intention, therefore, of the laws to create small holdings, and the precautions taken to prevent their perversion, the tendency to create large estates has not been altogether prevented. But the result of the policy has, on the whole, attracted to the land small industrious farmers, who have paid off their debts, become independent, and constitute one of the most stable elements of the population. Nevertheless the Commission of 1904 concludes its report with the following sinister reflection*:—

"Detailed study of the practical operation of the present land laws, particularly of the Desert Land Act and the commutation clause of the Homestead Act, shows that their tendency far too often is to bring about land monopoly rather than to multiply small holdings by actual settlers. The land laws, decisions, and practices, have become so complicated that the settler is at a marked disadvantage in comparison with the shrewd business man who aims to acquire large properties. Not infrequently their effect is to put a premium on perjury and dishonest methods in the acquisition of land. It is apparent, in consequence, that in very many localities, and perhaps in general, a larger proportion of the public land is passing into the hands of speculators and corporations than into those of actual settlers who are making homes.

"This is not due to the character of the land. In all parts of the United States known to your Commission, where such large holdings are being acquired, the genuine homesteader is prospering alongside of them under precisely the same conditions. Wherever the laws have been so enforced as to give the settler a reasonable chance he has settled, prospered, built up the country, and brought about more complete development and larger prosperity than where land monopoly flourishes. Nearly everywhere the large landowner has succeeded in monopolising the best tracts, whether of timber or agricultural land. There has been some outcry against this condition. Yet the lack of greater protest is significant. It is to be explained by the energy, shrewdness, and influence of the men to whom the continuation of the present condition is desirable.

"Your Commission has had inquiries made as to how a number of estates, selected haphazard, have been acquired. Almost without exception collusion or evasion of the letter and spirit of the land laws was involved. It is not necessarily to be inferred that the present owners of these estates were dishonest, but the fact remains that their holdings were acquired or consolidated by practices which cannot be defended.

"The disastrous effect of this system upon the well-being of the nation as a whole requires little comment. Under the present conditions, speaking broadly, the large estate usually remains in a low condition of cultivation, whereas under actual settlement by individual home-makers the same land would have supported many families in comfort and would have yielded far greater returns Agriculture is a pursuit of which it may be asserted absolutely that it rarely reaches its best development under any concentrated form of ownership.

"There exists, and is spreading in the West, a tenant or hired labour system which not only represents a relatively low industrial development, but whose further extension carries with it a most serious threat. Politically, socially, and economically this system is indefensible. Had the land laws been effective and effectually enforced its growth would have been impossible.

"It is often asserted in defence of large holdings that, through the operation of enlightened selfishness, the land so held will eventually be put to its best use. Whatever theoretical considerations may support this statement, in practice it is almost universally untrue. Hired labour on the farm cannot compete with the man who owns and works his land, and if it could the owners of large tracts rarely have the capital to develop them effectively.

"Although there is a tendency to subdivide large holdings in the long run, yet the desire for such holdings is so strong, and the belief in their rapid increase in value so controlling and so widespread, that the speculative motive governs, and men go to extremes before they will subdivide lands which they themselves are not able to utilise.

"The fundamental fact that characterises the present situation is this: That the number of patents issued is increasing out of all proportion to the number of new homes."

* Report of the Public Lands Commission, 1904, p. xxiii.

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It is beyond my purpose to refer to Canadian subjects, but I cannot refrain from making an extract from the report of the Public Lands Commission already referred to (p. 79), reflecting favourably on Canadian land laws:—

"If it were intended by your instructions of July 25th, 1904, to have this Committee recommend or suggest changes in the Free Homestead Act in its judgment necessary to obtain in a greater measure the objects sought for by Congress, your Committee would first refer to certain features contained in the Homestead Act enacted by the national legislative branch of the Canadian Government. Ample opportunity has been given your agent having in charge the commutation clause of the Homestead Act to watch the workings of the Canadian law, and make comparisons between it and our own free homestead law. No better example of this can be found than along the Rainy River, which forms the boundary line between the State of Minnesota and the Province of Ontario, extending over a stretch of territory nearly 100 miles in length. Along the southern bank of this river hundreds of entries have been made under our Free Homestead Act, the Timber and Stone Act, and the commutation clause of the Homestead Act, and the result has been that, with the exception of some half-dozen well-conducted farms, the territory is uninhabited, and presents a general appearance of virgin forest, stretching from the eastern end of Rainy Lake to the Lake of the Woods on the west.

"On the Canadian side of this river the timber has been disposed of on a stumpage basis and the land thrown open to settlement under the Canadian homestead law, requiring as it does specific acts by the entrymen as to residence and cultivation, and prescribed periods and acreage each year during the life of said entries. The result of this system has been that to-day the entire northern shore of the Rainy River is inhabited, and the territory under a high state of cultivation. Fine farms are everywhere to be found, while on the American side just the reverse is true. On the Canadian side roads have been built and school districts established, while on the American side few internal improvements are to be found. The soil is identical and natural conditions are the same, so no other theory can be advanced for the present condition of things than that the Canadian system is more conducive to actual settlement and cultivation.

"Your Committee has endeavoured to confine itself to facts, and treat the subject from the impartial standpoint, and the evidence seems clear and convincing that the Act has resulted in fraud, speculation, destruction of forests, the placing of thousands of acres in the hands of a few persons or corporations, and the stultifying of honest and industrious settlement and improvement of the public domain. Almost every good, honest citizen, unbiased by personal interest or greed, was emphatic in denouncing the commutation clause of the Homestead Act and demanding its repeal. In some cases it was found that men who had formerly profited by its workings and retired from active usiness, were now demanding its repeal in terms which could not be misunderstood."

Railroad Land Grants.

More land was in the past given as a bonus to encourage railroad building than has been transferred to homesteaders. The earliest grants were made in 1850, and those prior to 1862 were made to States as trustees and agent of transfer for the railroads. Only three grants were made after 1870, and about 75 per cent. of the whole was in the encouragement of trans-continental roads. The lands ceded to encourage railroad building were in the territories adjacent to the assisted roads. The largest grants were of land contiguous to the early trans-continental roads—the Union and Kansas Pacific, the Central Pacific, the Northern Pacific, the Southern Pacific, and the Santa Fé. In all, seventy-nine land grants were made, covering nearly 200,000,000 acres, but, "by reason of forfeiture by Congress because of the failure of the grantees to construct the roads as required by the granting Act, this amount was reduced to such an extent that the acreage at this time is estimated at 155,000,000 acres."*

Most of the land, especially the lumber land, was unsaleable at the time, and was therefore merely a prospectively valuable asset. It, however, assisted the roads in raising funds, and it is charged that the roads, owing to the rising value of both agricultural and lumber lands, are not over-zealous in trying to dispose of their extensive unsold holdings. Mineral lands were not intentionally granted. And where such minerals, including oil, have been found, the right of the concessionaire to enjoy this advantage is being questioned by the administration.

Though the Government no longer makes grants of land to encourage the building of the large railroads, it still cedes the use of the right of way and a certain acreage for station grounds to any railroad traversing the public domain.

To encourage the building of the first trans-continental roads, Congress lent large sums to the companies, which have been returned. But the need of transportation was so urgently felt by the population of thinly settled districts, that exemption of taxes for limited periods, bonuses by municipalities and counties of station grounds and rights of way, and even grants of money, were made. But of late such encouragement has been seldom extended to railroad

* Report of the Public Lands Commission, 1904.

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builders. In fact, the direction of public feeling has been generally hostile to the railroad companies.

Grants of Public Lands to Territories and States.

The Federal Government generally confers on newly-created Territories and States large tracts of land for specific purposes, retaining, however, the greater portion, including coal and mineral lands. The grants to States and Territories up to November, 1904, were:—

	Acres.
For common schools	69,058,443
For charitable, educational, penal, and reformatory institutions	8,539,464
For internal improvements	10,631,482
For public buildings	1,162,731
For salt springs and contiguous tracts	606,045
	89,998,165

Until thinly populated sections of the Republic had been endowed with the responsibilities and privileges of Statehood, they enjoyed a limited self-government, as Territories, under the supervision of Congress. But the land within the Territories was retained by the National Government, with the exception of such grants as may have been entrusted to the Territorial Government to be sold for special purposes. On the creation of States, Congress has not followed a uniform rule in its grants of public lands to the new self-governing communities, but has always endowed them most liberally with land for educational purposes. As early as 1785 an Ordinance was passed assigning 680 acres of land, or one thirty-sixth of the entire public domain, to every township "for the maintenance of public schools within said township." And every new State since the admission of, and including, Oregon, has received an additional grant of the thirty-sixth section. Land grants to new States for the maintenance of universities and agricultural colleges have been the rule. In all cases the Federal Government have aimed at excluding known mineral lands from the control of new States; but they have otherwise been amply provided with the means—if wisely disposed of—for educating their children in even more advanced studies than the elements.

Texas has been an exception; for, being an independent republic when incorporated into the Union, one of the conditions of Texan annexation was that she should "retain all the vacant and unappropriated lands lying within its limits, to be applied to paying the debts and liabilities of Texas, and the remainder of said lands, after discharging such debts and liabilities, to be disposed of as said State may direct; but in no event are such debts and liabilities to become a charge upon the Government of the United States." But Texas is liberal in the support of education. The Constitution of 1876 assures to the School Fund of Texas half the proceeds of the sale of public lands. (Report of the Public Lands Commission, p. 33.)

Indian and Military Reservations.

For Indian reservations, 70,448,126 acres have been appropriated, but this area can be cut down by Act of Congress or Executive order, when the reservation was assigned to a tribe by the action of the President.

The treatment of the Indians by the United States Government has been a subject of acute controversy, both at home and abroad. Large tracts of rich agricultural and grazing lands were allotted to them as reservations when their character and value were not known even by the administration. That it should remain a wilderness with cultivation all around was an intolerable condition. I have twice driven across the Sioux reservation from St. Pierre, on the Missouri, to Rapid in the Black Hills—across more than a hundred miles of the richest prairie in Dakota, without seeing a single Indian or an acre of cultivation. Some remedy for such anomalies had to be found.

As to the military reservations, most of them have been restored to the public domain, when abandoned, owing to the present system of army concentration. The expansion of the railroad system throughout the Rocky Mountains renders unnecessary a large number of isolated military posts.

National Parks.

Of late years large areas of the public domain which are remarkable for the possession of great natural beauty, like the Yellowstone Park in Montana, or the Yosemite in California, have been secured from desecration, or from private ownership, by conversion into national parks; and, to rescue prehistoric and historic monuments, the land on which they stand, if not owned by the Government, may be acquired by purchase, and set apart under the National Monument Act. These appropriations are evidences of a certain æsthetic and historical sense in the popular character, with which it is not generally credited.

Desert Land Act.

Under the Desert Land Act, 10,175,006 acres have been ceded to entrymen in blocks of a square mile, on condition that a certain portion

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of each entry be adequately irrigated. In applying this, and the provisions of all other statutes, curious anomalies inevitably occur.

Land to be Irrigated under Reclamation Service.—Of the millions of acres still within the public domain a considerable portion is within the Arctic circle, rich, doubtless, in mineral, but of little value for forestry or agriculture. Of the balance, by far the larger quantity is comprised within the Rocky Mountains, and therefore within not only the barren but the arid zone. Of this, 1,900,000 acres are already under process of being irrigated by the Reclamation Service. Some of the projects aim at storing flood waters by damming mountain torrents; others attain the same object by raising the level of lakes, and still others will draw water, loaded with fertilising material from such comparatively large and sluggish rivers as the Colorado and the Rio Grande. This work is being done at the expense of the Federal Government, and by the Reclamation Service, under the direction of the United States Geological Survey.

"The total sum set aside for all classes of projects is $34,270,000, and the amount of land to be irrigated is 1,909,000 acres. The average value of irrigated land in the United States is $47 per acre. This acreage will, therefore, add $89,723,000 to the taxable property of the United States in land values alone. According to the census report of 1900, the average annual income from irrigated land is $15 per acre. On this basis an income of $28,735,000 per annum will be added to the nation's wealth."

The figures are, of course, departmental calculations.

While the policy of the Government is to withdraw from corporate control in the future the forests and the waters of the public domain, whether available for power generation or irrigation, small holdings in the arid region will be irrigated by pumping, when underground flow is near the surface, and by catching the rainfall in artificial reservoirs. Such irrigation projects are carried out by corporations, associations of ranchers, or by individuals, and will undoubtedly render fertile a large acreage of desert land in small separate areas.

Timber and Stone Acts.

Three and a half million acres of timber land have been sold in California, Oregon, Nevada, and Washington, at $2.50 per acre under the Timber and Stone Act (Public Timber Laws, p. 98). The entrymen can take up only 160 acres; but this provision has not prevented the forest lands passing into the possession of large proprietors, either through purchase from entrymen or by the use of lieu land scrip—that is, scrip which has been issued as a reward for military and other service, and as a bonus to the railroads. Some such scrips are or have been transferable, and good, therefore, for the purchase from Government of certain classes of land. To avoid the destruction of the forests through wasteful methods of lumbering, forest fires, and other preventable causes, the President has used the authority conferred on him by the Act of March 3rd, 1891, to withdraw from the public domain and create as forest reserves "public lands wholly or in part covered with timber or undergrowth." Lumbering may, however, be conducted under licence on these reservations, and agricultural lands upon the same may be disposed of. The acreage now included in the 150 national forests is 194,505,325 acres. (Report of the Commissioner of General Land Office for 1909, p. 31.)

Mineral Land Laws.

While the homestead laws continue to meet with popular approval, it is very generally recognised that the laws under which desert land, and those under which coal, mineral, timber and stone lands can be secured, should be radically amended. These laws were all passed with the object of stimulating mining, quarrying, and of encouraging the reclamation of the country's desert districts. Some of the measures erred in the direction of over-liberality, while others were framed to put, as it was hoped, the minerals as well as the land into the possession of the poor man, and prevent their being monopolised by wealthy corporations. But in every case the policy was to develop the natural resources as speedily as possible and induce population to enter. The policy has succeeded so far beyond anticipation that if the legislators of a generation ago had been able to foresee the rapidity with which wealth would grow, and the national resources be proportionately used up, they might have hesitated to frame measures as generous as those which have attracted to the country the most enterprising spirits of all Europe, and to have afforded to men of magnificent powers of imagination and organisation, aided by great wealth, the material for creating huge enterprises, which it is now found more difficult to control than it was to create.

In the colonies before the Revolution the title to the common minerals passed, under the common law rule, to the owner of the soil, and the colonies, when they entered the Federation, retained control of these lands. But the mineral lands owned by the United States after the Revolution were disposed of under three statutes.

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1. An Ordinance (May, 1785), entitled "An Ordinance for ascertaining the mode of disposing of lands in the Western Territory," which was of the vaguest character.

2. The Lode Law of 1866.

3. The General Mining Law of 1872, known as the Law of the Apex.

There was substantially no mining done in the United States till the purchase of Louisiana and the acquisition of the lead mines of Missouri, which had been one of the most alluring baits of Law's Mississippi scheme. As a result of the Louisiana purchase, a law was passed in 1807 to the effect that "the President of the United States shall be and is hereby authorised to lease any lead mine which has been or may hereafter be discovered in the Indian Territory for a period not exceeding five years." The leasing of mineral lands was entrusted to the War Department, but it did not impose on it a heavy burden till 1845, when, after the extinction of the Michigan Indian titles in 1843, active mining commenced in the native copper deposits of Lake Superior. For two years only, subsequently to 1845, the system of leasing was carried out. It was the system inherited from the Mother country, but badly practised when applied on the large scale by inexperienced officials.

The Hon. Abraham S. Hewitt, in his interesting address to the American Institute of Mining Engineers on "A Century of Mining," tells of the process by which the leasing system was supplanted by the out-and-out purchase system* :—

"For a few years the rents were paid with tolerable regularity, but after 1834, in consequence of the immense number of illegal entries of mineral land at the Wisconsin land office, the smelters and miners refused to make any further payments, and the Government was entirely unable to collect them. After much trouble and expense, it was, in 1847, finally concluded that the only way was to sell the mineral land, and do away with all reserves of lead or any other metal, since they had only been a source of embarrassment to the department.

"Meanwhile, by a forced construction (afterwards declared invalid) of the same Act, hundreds of leases were granted to speculators in the Lake Superior copper region, which was from 1843 to 1846 the scene of wild and baseless excitement. The bubble burst during the latter year; the issue of permits and leases was suspended as illegal, and the Act of 1847, authorising the sale of the mineral lands and a geological survey of the district, laid the foundation of a more substantial property."

It may be doubted whether reform of the working of the leasing system, instead of its abolition, would not have been a wiser course; but the radical step of alienating absolutely the mineral lands was recommended by President Polk on December 2nd, 1845, and enacted into law, and the copper lands of Michigan were offered for sale at $5 an acre, the price at which mineral lands have ever since been disposed of.

The principal argument adduced by President Polk for the change of policy is the unprofitableness of leasing. He says:—

"According to the official records, the amount of rents received by the Government for the years 1841, 1842, 1843, and 1844, was $6,354.74, while the expenses of the system during the same period, including salaries of the superintendents, agents, clerks, and incidental expenses, were $26,111.11, the income being less than one-fourth of the expense. To this pecuniary loss may be added the injury sustained by the public in consequence of the destruction of timber, and the careless and wasteful manner of working the mines."

But President Fillmore, in his annual message to Congress on December 2nd, 1849, referring to the application of the land laws to the newly-acquired territory of California, gives as the most logical reason for the out-and-out sale of the public lands that "the relation of debtor and creditor between the citizens and the Government would be attended with many mischievous consequences." The public feeling in favour of actual ownership of land has always been strong.

The first mining excitement followed the first successful effort to mine the metallic copper of Lake Superior, and, as we have seen, the result was the adoption of the sale in preference to the lease system. The next modification of importance followed the rush for gold in California, then a remote section, newly acquired by conquest and subsequent treaty. To meet local exigencies, a mining code was framed by the miners, through methods curiously illustrative of the working of popular institutions.

When California was occupied by the United States the Mexican mining laws were in force, and till 1849 the conquered province remained under military rule. Colonel Mason, the governor, while still ignorant that the treaty of Guadaloupe Hidalgo had been signed on February 2nd, issued the following proclamation from Monteray on February 12th, 1848:—

"From and after this date the Mexican laws and customs now prevailing in California relative to the denouncement of mines are hereby abolished.

* *Transactions of the American Institute of Mining Engineers*, Vol. V. p. 181.

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"The legality of the denouncements which have taken place, and the possession obtained under them since, till the occupation of the country by the United States forces, are questions which will be disposed of by the American Government after a definitive treaty of peace shall have been established between the two Republics."

Without questioning the right of Colonel Mason to revoke arbitrarily the existing mining law, the miners obeyed, and framed rules and regulations, not only for regulating the conduct of mining, but for the mode of acquiring the mines themselves, although all of them were virtually trespassers on the public domain.

Hence arose the custom, afterwards embodied in the United States statute, of allowing neighbouring miners to create a mining district and constitute themselves into a legislative body, whose rules and regulations, if not contrary to either Federal or State or Territorial laws, have a binding obligation. These self-constituted legislators in California followed the Mexican code so far as it applied to discovery and development, but they introduced into their mining code a principle which had no place in any modern mining statute. To them the ownership of the surface was subsidiary to that of the lode or quartz vein, which might happen to crop out at any given spot. Therefore they conceded to the owner of the outcrop the right to follow his discovery to any depth, and under the "dip, spur, and angle clause" of their amateur regulation, created extra-lateral rights and introduced the law of the Apex, which came to be the distinguishing feature of the statutes passed in 1866 and 1872, and which has remained unaltered till to-day. This anomalous law of the Apex was apparently copied from an old custom confined to the High Peak district of Derbyshire, and probably incorporated in the California mining code at the suggestion of some English miners. Judge Field, who was ultimately elevated to the Supreme Court of the United States, but who had been one of the pioneers of California —an *alcalde* before the admission of the State— a legislator in the first Assembly, and a State judge, thus graphically describes the process by which these mining regulations were framed by these early intelligent miners:—

"The discovery of gold in California was followed, as is well known, by an immense immigration into the State, which increased its population within three or four years from a few thousand to several hundred thousand. The lands in which the precious metals were found belonged to the United States, and were unsurveyed and not open by law to occupation and settlement. Little was known of them further than that they were situated in the Sierra Nevada mountains. Into these mountains the emigrants in vast numbers penetrated, occupying the ravines, gulches and canyons, and probing the earth in all directions for the precious metals. Wherever they went they carried with them that love of order and system and of fair dealing which are the prominent characteristics of our people. In every district which they occupied they framed certain rules for their government, by which the extent of ground they could severally hold for mining was designated, their possessory right to such ground secured and enforced, and contests between them either avoided or determined. These rules bore a marked similarity, varying in several districts only according to the extent and character of the mines; distinct provision being made for different kinds of mining, such as placer mining, quartz mining, and mining in drifts and tunnels. *They all recognised discovery*, followed by appropriation, as the foundation of the possessor's title, and development by working as the condition of its retention. And they were so framed as to secure to all comers within practicable limits absolute equality of right and privilege in working the mines. Nothing but such equality would have been tolerated by the miners, who were emphatically the law-makers, as respects mining upon the public lands in the State. The first appropriator was everywhere held to have, within certain well-defined limits, a better right than others to the claims taken up; and in all controversies, except as against the Government, he was regarded as the original owner, from whom title was to be traced . . . These regulations and customs were appealed to in controversies in the State courts, and received their sanction; and properties to the value of many millions rested upon them. For eighteen years, from 1848 to 1866, the regulations and customs of miners, as enforced and moulded by the courts and sanctioned by the legislation of the State, constituted the law governing property in mines and in water on the public mineral lands."

The Argonauts not only carried to the west coast the habits of self-government which were the heritage of the race, but carried them into practice with the same independence and originality as characterise most of the legislation of the colonists of Australia.

The rapid development of the Comstock Lode, after its discovery in 1859, rendered the framing of a Federal mining law a matter of necessity, and therefore in 1866 Congress enacted the first law under which a Federal title could be obtained to Federal mining land. The provisions of the Act are as vague as its title—"An Act granting the right of way to ditch and canal owners through the public lands, and for other purposes." Lindley says (I. p. 53):—

"The title gives no clue to the scope of the Act. As a matter of fact, the title belonged to another

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Act which had passed the house, and for which the Mining Act was substituted in the Senate, without any attempt to change the title, and in this form passed both houses."

The Act provided:—

"1. That all the mineral lands of the public domain should be free and open to exploration and occupation;

"2. The rights which had been acquired in these lands under a system of local rules, with the apparent acquiescence and sanction of the Government, should be recognised and confirmed;

"3. That titles to at least certain classes of mineral deposits or lands containing them might be ultimately obtained."

The Act, however, which is still in force, is that passed in 1872 as "An Act to Promote the Development of the Mining Resources of the United States." The Act expresses decisively the liberality with which the country has disposed of its mineral lands, and the result has certainly justified its title and intent. The Preamble states:—

"Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled. 1. That all valuable mineral deposits in land belonging to the United States, both surveyed and unsurveyed, are hereby declared to be free and open to exploration and purchase, and the lands in which they are found to occupation and purchase, by citizens of the United States, and those who have declared their intention to become such, under regulations prescribed by law, and according to the local customs or rules of miners, in the several mining districts so far as the same are applicable and not inconsistent with the laws of the United States."

The extent of the mining claim is prescribed as follows:—

"A mining claim located after the passage of this Act, whether located by one or more persons, may equal, but shall not exceed, one thousand five hundred feet in length along the vein or lode; but no location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located. No claim shall extend more than three hundred feet on each side of the middle of the vein at the surface, nor shall any claim be limited, by any mining regulation, to less than twenty-five feet on each side of the middle of the vein at the surface, except where adverse rights existing at the passage of this Act shall render such limitation necessary. The end lines of each claim shall be parallel to each other."

The extralateral rights of the early California regulation are secured to the locator under the Federal law, under the third clause of the Act:—

"That the locators of all mining locations heretofore made . . . shall have the exclusive right of possession and enjoyment of all the surface included within the lines of their locations and of all veins, lodes or ledges, throughout their entire depth, the top or apex of which lies inside of such surface lines extended downward vertically, although such veins, lodes or ledges may so far depart from a perpendicular in their course downward as to extend outside the vertical side lines of the said surface locations; provided that their right of possession to such outside parts of said veins or ledges shall be confined to such portions thereof as lie between vertical planes drawn downward as aforesaid, through the end lines of their locations, so continued in their own direction that such planes will intersect such exterior parts of said veins or ledges. And provided further, that nothing in this section shall authorise the locator or possessor of a vein or lode which extends, in its downward course, beyond the vertical lines of his claim, to enter upon the surface of a claim owned or possessed by another."

Whether granting these extralateral rights has advanced the progress of mining is a disputed question, but they have been the source of most protracted and costly litigation.

The Act prescribes the manner in which a mining claim must be monumented and recorded, and the amount of work which must be actually done upon it, either above or below ground per annum ($100 = £20) in order to secure possessory rights. No rent or royalty is exacted by the Federal Government, but after $500 have been expended on the claim, the possessory title may be converted into an absolute patented title by payment of $5 per acre. The Act is admittedly defective in many of its provisions, but it would be foreign to my purpose to discuss its shortcomings. My object is to emphasise the motive which actuated the people, through their legislators, in throwing open all their lands, agricultural and mineral, not only to occupation, but to actual ownership by citizens or by anyone who has "declared his intention to become such." Under the Homestead Act the agricultural land is given freely; under the mining law no charge is made for the possessory title, and for a patent to a mining claim the trifling price of £1 per acre, hardly enough to meet the administration cost of the land department. Considering the incalculable hidden mineral wealth of the western half of the continent, it is not to be wondered at if the active spirits of the world accepted the cordial invitation to share it on such liberal terms, and that it has been uncovered, developed and marketed with such extraordinary speed, at extravagant profits to some, and that it has created spasms of speculative mania which have not had a healthy effect on public morals.

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Mining companies are permitted the liberal allowance of 5,000 acres, but if a company reaches its limit, the same shareholders simply organise another. Metal mining, therefore, on a large scale can be carried on without evasion of any law.

Most of the coal and iron is mined east of the Missouri, and their possession passed to the owners of the land. But the gold and silver, and most of the copper and lead, are produced in the Rocky Mountains States under the liberal Federal laws which we have described. The sum total in value for 1908, as given by the United States Geological Survey, is as follows:—

Non-metallic products	$1,045,497,000
Metallic ,, . . .	549,923,000
Unclassified	250,000
	$1,595,670,000

The value of the metals in 1910 is given by the mineral industry as $791,702,857

Assuming the most modest estimate of actual profits on this large sum, we begin to appreciate the wealth that is accumulating in the country. Nor does this all fall to the lot of the shareholders of the large mining companies. If we take, for instance, the 2,000,000 acres of mineral lands which have been sold by the Federal Government, by far the largest proportion has been first located by prospectors and sold at often high figures. The poor man has been given the prospects, gratis, by the Federal Government, while the corporation has paid him the higher value of a promising, though perhaps undeveloped holding. Comparatively little actual mining is done by the poor man. He avoids doing more than will give presumptive value to his claim, and even if it proves to be a claim which may develop into a mine he obtains for it a high speculative value.

Coal Land Laws.

The Coal Land Laws, regulating the sale of coal lands, date from July 1st, 1864, and March 13th, 1865, but the Act under which most of the coal lands have been sold came into effect in 1873.

The coal land laws offer an interesting study of good intentions misapplied. The law-makers applied to coal lands the rules which were quite applicable to agricultural lands. They did not offer the coal for nothing, but they put a very small value on the land which covers it, and parted with land and coal together.

But the law limits the amount of coal land which can be taken under a single entry to 160 acres—the agricultural quarter section—and forbids more than two continuous entries to be consolidated into a working organisation. After the formalities have been fulfilled and the land paid for, as in the case of agricultural land, the entryman can do what he likes with his own property, but if he has made a contract, implied or expressed, to sell his coal, before he actually obtains his patent, he is subject to criminal action and the forfeiture of his property. The coal land entries, from the passage of the Act, March 3rd, 1873, to June 30th, 1909, were 3,558, covering 7,675,992 acres. (Report of the Public Lands Commission, 1909, p. 42.)

The coal land laws, under which all coal lands under control of the Federal Government have heretofore been disposed of, provide that—

"Every person above the age of twenty-one years, who is a citizen of the United States, or who has declared his intention to become such, or any association of persons severally qualified as above, shall, upon application to the register of the proper land office, have the right to enter, by legal subdivisions, any quantity of vacant coal lands of the United States not otherwise appropriated or reserved by competent authority, not exceeding one hundred and sixty acres to such individual person, or three hundred and twenty acres to such association, upon payment to the receiver of not less than ten dollars per acre for such lands, where the same shall be situated more than fifteen miles from any completed railroad, and not less than twenty dollars per acre for such lands as shall be within fifteen miles of such road."

The declaration which the entryman makes is as follows:—

"I, ______________, hereby apply, under the Provisions of 'the Revised Statutes of the United States,' relating to the sale of coal lands of the Township of ____________, of range ____________, in the district of lands subject to sale at the land office at ______________, and containing ____________ acres; and I solemnly swear that no portion of said tract is in the possession of any other party; that I am twenty-one years of age, a citizen of the United States (or have declared my intention to become a citizen of the United States), and have never held nor purchased lands under said Act, either as an individual or as member of an association; and I do further swear that I am well acquainted with the character of said described land, and with each and every legal subdivision thereof, having frequently passed over the same; that my knowledge of said land is such as to enable me to testify understandingly with regard thereto, that said land contains large deposits of coal, and is chiefly valuable therefor; that there is not, to my knowledge, within the limits thereof any vein or lode of quartz or other rock in place bearing gold, silver or copper, and that there is not within the limits of said land, to my knowledge, any valuable deposit of gold, silver or copper. So help me God."

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The affidavit is so worded that it renders liable to prosecution for perjury every entryman who has even a remote intention of selling his claim, and not working it himself. But the law heretofore has been administered with reasonable latitude. Still it is manifestly inapplicable to the present industrial conditions.

President Roosevelt, in his Message to Congress on December 17th, said:—

"I am gravely concerned at the extremely unsatisfactory condition of the public land laws, and at the prevalence of fraud under their present provisions. For much of this fraud the present laws are chiefly responsible. There is but one way by which the fraudulent acquisition of these lands can be definitely stopped, and therefore I have directed the Secretary of the Interior to allow no patent to be issued to public lands under any law until by an examination on the ground actual compliance with that law has been found to exist. For this purpose an increase of special agents in the General Land Office is urgently required; unless it is given, *bona fide* would-be settlers will be put to grave inconvenience, or else the fraud will in large part go on.

"Further, the Secretary of the Interior should be enabled to employ enough mining experts to examine the validity of all mineral land claims, and to undertake the supervision and control of the use of the mineral fuels still belonging to the United States. The present coal law limiting the individual entry to 160 acres puts a premium on fraud by making it impossible to develop certain types of coal-fields and yet comply with the law. It is a scandal to maintain laws which sound well, but which make fraud the key without which great natural resources must remain closed. The law should give individuals and corporations, under proper Government regulation and control (the details of which I shall not at present discuss), the right to work bodies of coal land large enough for profitable development. My own belief is that there should be provision for leasing coal, oil, and gas rights under proper restrictions. If the additional force of special agents and mining experts I recommend is provided and well used, the result will be not only to stop the land frauds, but to prevent delays in patenting valid land claims, and to conserve the indispensable fuel resources of the nation."

The President's recommendation to amend the laws in the direction of leasing instead of selling did not meet with the approval of Congress, which adheres to the traditional national preference for private ownership. President Taft favours leasing.

The Commissioner of the General Land Office in his report for 1909 to his superior, the Secretary of the Interior, says, under the heading "Coal Land Legislation":—

"Attention is called to this because of the demand for the conservation of the natural resources, and because of the entire inadequacy of present legislation either for the conservation or for the proper development of either coal or oil lands. In his Message to Congress at the beginning of the first session of the Sixtieth Congress, President Roosevelt endorsed your recommendation in the following words:—

"'In my judgment the Government should have the right to keep the fee of the coal, oil, and gas fields in its own possession and to lease the rights to develop them under proper regulations; or else, if the Congress will not adopt this method, the coal deposits should be sold under limitations, to conserve them as public utilities, the right to mine coal being separated from the title to the soil.'

"After this endorsement of your recommendation, President Roosevelt, recognising the absurdity of present limitation in regard to area, added:—

"'The regulations should permit coal lands to be worked in sufficient quantity by the several corporations. The present limitations have been absurd, excessive, and serve no useful purpose, and often render it necessary that there should be either fraud or else abandonment of the work of getting out the coal.'

"The conditions which existed then exist to-day, and the situation which is thus created, and which was recognised by President Roosevelt, is as intolerable now as it was then.

"Any legislation in regard to the disposal of coal lands by lease or otherwise, should contain a strong anti-trust clause, and a provision which would prevent any agreement to abstain from mining the coal. If it should be determined to lease on a royalty, then unless such a clause be inserted, so that open competition may be maintained, the charge of the royalty will mean nothing more than that the public will pay the additional price. This would not in any way relieve the situation."

The result of the agitation so far has been that, as the administration could not get a law through Congress which met with general approval, President Roosevelt used his executive authority to withdraw all coal lands from entry, pending contemplated legislation and revised regulation. No new laws have been passed, but the Interior Department, through the Geological Survey, has been revaluing all the unceded coal lands in the public domain, assigning a specific value to each coal area, based upon the quality of the fuel, ease of extraction, facility for transportation, etc. The task is a difficult one, especially when applied to Alaska, where there are undoubtedly very large coal resources, but

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where little or no work has been done to determine the extent to which faulting has disturbed the beds or modified the character of the coal.

The agitation about the disposal of coal lands applies only to the quantity still under control of the Federal Government—viz., that of the Rocky Mountains and Pacific Coast section. Elsewhere in all the older States, except Louisiana,* the lands and the minerals beneath them, have become private property under the English common law rule.

The area of the coal lands of the United States is estimated by the United States Geological Survey at 496,776 square miles, of which 480 square miles consist of the anthracite coal lands of Pennsylvania, 148,609 square miles of lignite, leaving 250,051 miles of bituminous coal.† The same authorities estimate the quantity of coal of all grades contained under that area as follows:—

to be almost everywhere sold at lower figures than prevail in the metallurgical centres of Europe. Coal from many of the districts in the east, south and middle-west, is sold on the cars at 80 cents to $1 per ton of 2,000lbs., and $1.25 has been a high price in the west.

The conservation of the national resources of the country has recently become a prominent political issue, and has passed out of the domain of scientific inquiry and calm discussion into that of bitter partisan strife. That the laws are too liberal and too loosely administered is becoming the general opinion; but they have, from the point of view of national growth, been so eminently and conspicuously successful, that even those, who are most keenly sensible of their defects, hesitate to call a halt of the national progress by trying legislative experiments with them.

Mr. Ballinger's report as Secretary of the Interior for 1909, however, reflects the popular opinion when he makes strictures on the operation of the old land laws and recommendations for the future. He says:—

ORIGINAL COAL SUPPLY.

	Area.	Amount Easily Accessible.	Amount Accessible with Difficulty.	Easily Accessible and Available.
	Sq. Miles.	Short Tons.	Short Tons.	Short Tons.
Anthracite and bituminous . .	250,531	1,176,727,000,000	505,730,000,000	1,176,727,000,000
Sub-bituminous	97,636	356,707,000,000	293,450,000,000	..
Lignite	148,609	389,545,000,000	354,045,000,000	216,252,000,000
Total . . .	496,776	1,922,979,000,000	1,153,225,000,000	1,392,979,000,000

No large section of the country, except the New England States and California, is deprived of the blessing of its own fuel supply. New York and New Jersey are dependent on their neighbours for coal, but this dependence is really geographical, not economical.

This wide and almost uniform diffusion of the essential element of industrial development has contributed largely to rendering possible the material progress of the country; while at the same time it has been politically a unifying force by diffusing manufactures and reducing the dangerous sectionalism, which at one time grew out of the prevalence of localised agricultural and manufacturing interests and prejudices. The large area of the coal-fields, as well as the favourable structure and deposition of the bituminous coal-beds (the bituminous beds being generally horizontal), has enabled coal and coke

"The proper use and disposition of the public lands have been questions involving no little legislative as well as administrative difficulty from the beginning of their history. They were, during the earliest administrations, treated as a national asset for the liquidation of the public debt and as a source of reward for our soldiers and sailors. Not until the discovery of gold on the Pacific slope did the policy change for one of exploitation, by which our citizens were encouraged to develop the mineral and agricultural resources of the public domain on condition of receiving limited areas at a nominal cost. For similar reasons, railway and wagon-road grants were liberally donated by Congress in order to add facilities for the opening up of these almost inaccessible regions.

"The railway grants generally were limited to non-mineral lands, except such as contained coal and iron, which latter minerals were taken to be

* "Land Question," Sato, p. 13.

† *Transactions of the American Institute of Mining Engineers*, Vol. XL. p. 254.

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essential for railway construction and operation. New States were, when admitted, liberally endowed with public lands for school and other purposes; so that, out of a public domain in 1860 of 1,055,911,288 acres (Alaska then not belonging to the United States), we now have only about 731,354,081 acres, confined largely to the mountain ranges and the arid and semi-arid plains, except lands within some of the Indian reservations and the 368,035,975 acres of undisposed-of land in Alaska.

"All of the principal land statutes were enacted over twenty-five years ago; the Homestead Act, the Pre-emption and Timber Culture Acts, the Coal Land, and the Mining Acts for the aid of the industrious prospector, were among the earlier Acts of this nature.

"The liberal and rapid disposition of the public lands under these statutes, and the lax methods of administration which for a long time prevailed, naturally provoked the feeling that the public domain was legitimate prey for the unscrupulous, and that it was no crime to violate or circumvent the land laws. It is to be regretted that we, as a nation, were so tardy to realise the importance of preventing so large a measure of our natural resources passing into the hands of land pirates and speculators, with no view to development looking to the national welfare. It may be safely said that millions of acres of timber and other lands have been unlawfully obtained, and it is also true that actions to recover such lands have in most instances long since been barred by the Statute of Limitations. The principal awakening to our wasteful course came under your predecessor's administration. The bold and vigorous prosecutions of land frauds, through Secretaries Hitchcock and Garfield, have restored a salutary respect for the law, and the public mind has rapidly grasped the importance of safeguarding the further disposition of our natural resources in the public lands in the interest of the public good as against private greed. Notwithstanding this, it is necessary to continue with utmost vigour, through all available sources, the securing of information of violations of the public land laws, and to follow such violations with rigid prosecutions.

"In this present policy of conserving the natural resources of the public domain, while development is the keynote, the best thought of the day is not that development shall be by national agencies, but that wise utilisation shall be secured through private enterprise under national supervision and control. Therefore, if material progress is to be made in securing the best use of our remaining public lands, Congress must be called upon to enact remedial legislation."

These strictures are hardly fair, and are perhaps too sweeping. The old laws were framed to encourage the development of the country. As is the case the world over, certain men of exceptional foresight and ability used them to secure from the public domain, at a trifling price—but not necessarily or generally by fraud—large areas, especially of coal, oil and mineral lands, which when developed have proved, especially under the protection of the tariff, of enormous value. Their value was not appreciated when the laws were made, and these laws did not prevent any citizen who came into possession of land as a gift from the State or as entryman of a homestead, or as the purchaser of a quarter section of coal lands, from selling it to a corporation, once he had acquired a patent. While some coal lands were probably acquired under the Homestead Act, and then disposed of as coal lands, the Government thus being defrauded out of $15 an acre, most coal and mineral lands have been legally acquired with the land or from the original locators, or under old Mexican grants in Colorado and New Mexico, by the only holders who could work them safely and economically, by modern mechanical methods. The law-makers of the first statutes, and the many legislators who have, since conditions have altered, recognised the defects of the old laws and yet have not possessed the courage to amend them, were more at fault than the men, whose accumulation of such stupendous wealth under these laws has alarmed the public. If they had not developed the country's resources, there would not have been over 80,000,000 of people to upbraid them. Mere technical evasion of the laws, admittedly defective, should not be laid as wilful infraction to the charge of the men who have built up the great national industries. That in the rush for wealth and the production of quantity there has been waste is beyond question; but economy of necessity follows experiences of waste and of knowledge how to avoid it, and none are more anxious to save than the big financial industrial corporations. Both in America and elsewhere domestic waste far exceeds industrial waste.

That these laws should have remained so long unamended, while such radical changes have taken place in the industrial condition of the country, is attributed by the Public Land Commission to the public "dread of the introduction of unfamiliar requirements, and the fear that new enactments may recognise physical conditions even less than present ones, and may be even less suited to the needs of the country. By the use of practice, sanctioned by custom, the people have heretofore been able to get along fairly well; any change in their mind is associated with more difficult requirements, and they dread innovations which may hinder rather than help home-making."

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The Railroad Policy of the United States.

Every modern community the world over has depended largely on its railways and its railway policy for the speed with which it has developed. The early railway legislation of the United States, like that affecting the sale of agricultural and mineral lands, was framed with the motive of encouraging the building of roads rather than of controlling capitalisation or regulating traffic. It answered its purpose, for the activity in railroad building has been prodigious. It has not only kept pace with the development of the country's industries, but has really in most sections helped to create them. As one result, Meyer says* truly that "railway legislation in the United States is full of inconsistencies and anomalies, spasmodic expressions of legislative impulses, and the futile attempts of administrative bunglers." This was almost unavoidably the case, and was in part due to constitutional necessities which gave control only of inter-State railroads to the Federal Government, and permitted it to legislate only on inter-State traffic or the management of inter-State roads. As, however, the handling of mails falls within the province of the Federal Government, and as the great bulk of business, and far the greatest number of rates, are inter-State, the interference of the Federal Government has steadily increased. And if the States would waive their rights to regulate inter-State roads and traffic, Federal legislation, as it is likely to be more consistent than State legislation, would probably be favoured by most railroad managers. Absolute Federal control of railroads would be in line with the present centralising tendencies.

Another reason for the confusion in railroad legislation is the same reason that accounts for many of the anomalies in American life and in American municipal and State politics. The railroad system expanded, and the cities and the country's industries grew more rapidly than remedies for the correction of irregularities could be applied. For in the United States, as in every country where a vigorous population with exuberant energy preceded organised law, there is restlessness under regulation. The temper engendered by being a law unto one's self, becomes temporarily a trait of national character.

Meyer thus briefly describes the rise and progress of Federal legislation:—

"During the first half of the nineteenth century Federal railway legislation dealt chiefly with rights of way through public lands, and with the remission of duties on railway materials imported from abroad. The Pacific Railway agitation was begun during the first and continued into the third quarter of the century. The first land grant Act was passed in 1850. In 1866 the 'charter of the American railway system' became a law. It provided that 'every railroad company in the United States whose road is operated by steam, be and is hereby authorised to carry upon and over its road, boats, bridges, and ferries, all passengers, troops, Government supplies, mails, freight, and property, on their way from any State to another State, and to receive compensation therefor; and to connect with roads of other States so as to form continuous lines for the transportation of the same to the place of destination.' In 1868 the House Committee on roads and canals—the new committee to handle railway legislation did not appear until several years later—submitted a report in which strong reasons were advanced in favour of a liberal interpretation of the powers of Congress over inter-State commerce. The committee had been instructed to inquire whether Congress had power to regulate inter-State railways so as to secure safety of passengers, uniform and equitable rates, and adequate connections with other railways. An affirmative answer was given to every one of these points of inquiry, but the committee did not report a bill. This they refused to do because the requisite facts for the drafting of such a bill were not at hand. Instead, it was recommended that another committee be appointed to collect the data necessary for intelligent action. Meanwhile the Patrons of Husbandry had come upon the scene. From 1867 to 1872 the founders of the order struggled chiefly alone. In 1872 the State Grange of Iowa was founded, and by the close of that year about thirteen hundred granges had been organised in various parts of the country. In two years more the order had spread over the whole country, with an aggregate of over 20,000 lodges. In 1874 the Grand Master's address alluded to exorbitant and varying rates, discriminations, and uncertainties. 'When we plant a crop we can only guess what it will cost us to send it to market, for we are the slaves of those whom we created . . . In our inmost soul we feel deeply wronged at the return made for the kind and liberal spirit we have shown them' (i.e., the railways). Sentiments like these, frequently expressed in vehement language and repeated time without number in subordinate granges, created a profound influence on public opinion and political parties. Congress was petitioned to establish a department of agriculture, to revise the patent laws, improve the Mississippi River, and above all, to enact suitable railway legislation. 'We hold each senator and representative responsible for his action upon the subject-matter' set forth in the resolutions. The President's Message of December, 1872, gave the stimulus to the appointment of a Senate committee of seven, known as the Windom Committee. The report of this committee 'is interesting

* The best, short concise treatise on United States railway legislation is "Railway Legislation in the United States," B. H. Meyer, Ph.D. (The Macmillan Co.).

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because it contains the first presentation of a comprehensive plan of regulation of the whole subject of commerce between the States, as it has constituted itself since the introduction of the railway.' The primary view of the report was low rates and the preservation of competition. The crisis of 1873 tended to divert attention from discriminations and other abuses to the absolute level of rates, it being assumed that cheap rates would afford relief. Among the measures recommended by the Windom Committee were publicity of rates, prohibition of combinations, stock-watering, and a greater charge for a shorter haul over the same line, reforms in the shipment of grain and in the operation of freight lines, and, finally, the establishment of a bureau of commerce."

But it was not until 1886 that the Cullom Committee reported in favour of a Federal commission to regulate commerce. This followed a recent ruling of the Supreme Court, in the case of Munn *vs.* Illinois. This ruling was to the effect that "When the owner of property devotes it to a use in which the public has an interest, he in effect grants to the public an interest in such use, and must, to the extent of that interest, submit to be controlled by the public, for the common good, as long as he maintains the use. He may withdraw his grant by discontinuing the use."

The Inter-State Commerce Commission, with duties and functions as prescribed in the Act of 1887, was the result of the report of the Cullom Committee. The Elkins Act, the Hepburn Act, and amendations almost from year to year, have steadily enlarged the powers of the committee, as well as imposed severer penalties for infractions of the law. Besides possessing the right which the original Act conferred, to adjust unreasonable rates on complaint of an injured person or community, the Act known as the Hepburn Bill gives the Commission the power to investigate, at its own initiative, rates which they consider unjust. And a Court of Commerce has been created, to which appeal from the rulings of the Commission can be made so as to secure prompt action. The whole tendency of legislation, if not in the direction of State ownership, tends towards stricter Federal control over both the rate-making and the operation of the railroads; the issuing of securities as well as the issuing of passes, and the abolition of discrimination in any form.

The Cullom Committee's report and the first Act, framed on its recommendations, aimed at correcting the great discrepancies in rates between the long and the short haul, and the allowances which might be made to compensate for water and other competition. The difficulties of adjusting these complications have been so great that the problem is still unsolved. They grow out of the great distances covered by even a single system, and still more by connecting roads, the striking variation in the physical features of the different sections of the country, and the corresponding difference in the cost of operation. The wide range in the price of labour, and many other disturbing factors, make the adoption of a scale of absolutely uniform rates inapplicable, and therefore the problem of adjusting equitably such a host of differences on a total mileage of 230,000 miles is a task requiring not only enormous labour, but the exercise of extraordinary wisdom and skill. The Inter-State Commerce Commission has heretofore performed its difficult duties with such fairness and ability, and attempted to enforce the law so impartially, that the railroads have felt the benefit of escaping from the importunity of the shippers demanding illegal preference, and have greatly benefited instead of suffering through the passage of recent restrictive legislation. Pooling, or "combining in restraint of trade" (a very ambiguous term capable of wide interpretation), being strictly forbidden under the Sherman Act, the only remedy against the ruinous results of unbridled competition—or, at any rate, the one adopted—has been actual consolidation into great systems by purchase. The further this is carried the nearer it brings any country to State ownership. The political consequences of State ownership most people dread, considering that one million and a half of men—most of them enjoying the franchise —are on the pay-rolls of the railroads.

In the early days all railroads were built under separate State charters, but ere long most States and Territories passed general railroad laws. These differ widely in their provisions, so much so that the aim of some States has been to tempt railroad companies to incorporate under their laws by reason of the liberal terms they offer in organisation fees and in tax on capitalisation. These fees flow into the State's treasury. But a State charter does not imply that a single mile of the chartered road is built in the State, nor do all State statutes require that roads traversing a given State must be incorporated under the laws of that State, though every railroad operating in any State must obey its laws, and regulate their local rates, both passenger and freight, in conformity therewith. Almost every railroad, therefore, is subject to both State laws and Federal statutes. But, despite all these incongruities, the incorporation of railroads, and

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their construction under general statutes instead of under special charters, has tended towards the rapid development of this method of carriage, and towards the restrictions of inland water transportation.

The legal expense of incorporation is everywhere light, in striking contrast to the experience of European roads. Mr. Acworth, in his "Railroad Economics," calculates that the initial expense of securing the passage of a railroad charter through the British Parliament is £5,000 per mile. The actual cost of some American railroads, as first built, probably has not much exceeded that sum; for the first cost and their actual present value bear no relation to one another. Most roads have been built, in anticipation of freight and passenger traffic, with light rails on a poorly ballasted roadbed; with wooden culverts, and bridges only strong enough to carry comparatively light rolling-stock. As traffic increases, the road in all its features is improved, and large sections are generally rebuilt with lighter grades and reduced curves. The fixed charges of a new road with light traffic thus constitute a burden more easily borne than if it had been at once constructed on a higher standard.

This condition is one of the factors which have assisted the American roads in carrying freight at a lower rate than that of any other country; but to secure these rates the customers of the railroad have to forfeit some advantages enjoyed by others—notably punctuality of delivery. Still, the progress of the country has been due in great measure to the cheap transportation of commodities.*

Class rates are much higher, and there are notable discrepancies in the charges made for hauling the same distance between different points, and still greater incongruities between the tariffs on long and short hauls, especially when the long haul is to points where water competition has to be met.

As most long distances are covered only by transportation over several roads, rates and classifications are fixed by traffic associations, and divisions of the through rate are made by mutual understandings of the roads affected. As yet the Inter-State Commerce Commission has not interfered with the divisions, considering that the public is directly interested only in the rate itself.

The effect of the above-described policy and the liberal laws enacted after the Civil War is reflected in the growth of population. At the close of the Revolution (say in 1780) the population of the United States was 2,781,000. The census of 1800 gave 5,308,483 as the total population. It grew slowly for the next twenty years, for the ten years' growth to 1810 showed an increase to only 7,229,881; and in 1820 it was 9,638,453. It had risen when the Civil War broke out to 31,443,321. The census of 1880 shows an increase to 50,155,783; but that of 1900 a leap to 75,994,575, and the last census, that of 1910, places it at 91,972,267.

The population of the original area of the revolting colonies at the census of 1900 was 33,553,630, but it consisted of only about one-fourth of the present area of the United States.

Year.	Population.	Coal Production.	Consumption of Coal per head.
		Tons.	Tons.
1860	31,443,321	16,139,736	0·51
1870	38,558,371	36,806,560	0·96
1880	50,189,209	76,157,944	1·52
1890	63,069,756	157,770,963	2·50
1900	76,303,387	269,684,027	3·53
1910	91,972,267	444,203,801	4·83

The density of population at present in the older eastern and southern States is nearly twice as great as that of the country at large, indicating that the centres of industry are still not far from the Atlantic seaboard; but the trend of population and manufacturing is westward towards the rich prairie lands, yielding food supplies, which are being more and more manufactured into condensed products, and towards the minerals of the Lake Region and the Rocky Mountains. New England and the middle Atlantic States no longer monopolise manufacturing. Cotton is now made into cloth where the cotton is grown. The largest iron and steel works have been built near Chicago at Gary, where the Lake Superior iron ores are discharged directly into the furnaces from the ships. Meat-packing plants are established at Kansas City,

* The average rate of transporting coal in the eastern and middle States is about ·35 cents per ton mile, or less than one farthing per ton per mile. In the western States it is about one farthing per ton mile. Crude copper is carried from the great copper mining and smelting centres of Arizona, Utah and Montana at \$8 (£1 12*s.*) for an average distance of 2,000 miles, and pig-iron enjoys an average rate in the eastern, southern, and middle States of ·5843 cents per ton mile.

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central to the corn-growing States. This economical conversion of raw material into specialised manufactured form established near the place of origin, is rendered possible by the very wide distribution of coal and the low transportation charges on certain commodities. The table (p. 39) illustrates the manufacturing activity of the country, for the coal consumption per head is a true gauge of the growth of manufactures.

The coal consumed is the coal produced, as very little is exported.

The rate at which the coal is consumed per head of the population is out of all proportion to the growth of population, and even the increase in the production of coal itself. In England the coal consumption per head of population has shown but slight increase. It has been as follows:—

	Coal Raised.	Domestic Consumption.	Population.	Domestic Consumption per head of Population.
	Tons.	Tons.		Tons.
1870	110,431,192	112,603,503	32,177,550	3·499
1880	146,946,409	123,066,763	34,622,930	3·554
1890	181,614,288	142,954,016	37,484,764	3·814
1900	225,181,300	166,776,213	40,521,371	4·075
1909	263,774,373	177,737,306	—	—

From the final report of the Royal Commission on Coal Supplies, 1905, Part I. p. 27.

The consumption of fuel per head in England is not notably different from what it is in the United States, but England within the period under revision had already developed her manufacturing industries, and therefore has not proportionately increased her coal consumption per head. In the States we have been actively growing. But if the table of English consumption is to be accepted as a basis for prediction, it indicates that after a certain period, stability, rather than increase, becomes the rule, and that, therefore, consumption in the United States will not proceed in future in the same ratio as heretofore.

The activity of the Patent Office and the large proportion of patents taken out by the working mechanics, is a measure of the ingenuity of the people at large, and this and many other powerful but undefinable influences have combined with the written laws to shape the economic destiny of the Republic, especially since the great awakening in the sixties. But to discuss them would lead me out of the dominion of facts into the region of speculation.

DISCUSSION.

Lord Sanderson, G.C.B., K.C.M.G., after thanking Mr. Douglas for his paper, said it made one feel proud to know that the American nation, the progress of which had just been described in such glowing terms, originated from this island. As Mr. Douglas had proceeded with his account of the development of the United States, he (Lord Sanderson) confessed he wondered what would have happened if the United States had not separated from England—whether there would now be a British Cabinet in London, and if so what its composition would be. One or two points in the paper had struck him as being particularly interesting, the first being with regard to the question of land. Americans had always had the reputation of being very good men of business, and their Government had done exactly what other governments had in the past done, namely, when they had a large amount of land at their disposal they distributed it to private owners. That had happened almost all over the world. There was one place in particular where it was in the course of happening at the present time, namely Russia, where, for a long period, the tenure of land was communistic; but now it had been found that the only effective means of advancing husbandry was by the land being given into private ownership. At the present moment there was in this country a school of social reformers which maintained that the only way in which the land could possibly be utilised to its full advantage was by bringing it into the hands of the Government. There might be arguments in favour of that course, but it was at least a matter for very careful examination. With regard to the question of forests, the author had said there was much waste in America in that respect, but he (Lord Sanderson) was afraid that if any country, however business-like it might be, had any particular article in great abundance it would waste it. He remembered travelling in a railway train in this country with an American who, as they passed through the country, said he wondered why more wood was not used in England for the construction of houses. He replied that there was not much wood in this country, and that a good many other materials were more

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available for building purposes; and, as the author had observed, the tendency in America at present was to use much less wood in the construction of houses. No doubt if at any time the waste of wood in America was found to be of a really serious nature, the Government there would find means of stopping it. The same applied to the question of coal. As the author had explained the mining laws of America and how impossible they were, he (Lord Sanderson) had thought it was an instance of the great patience which was at times shown by the American citizen; but at the end of the explanation it had turned out that notwithstanding these laws the American people obtained all the coal they wanted. He ventured to ask whether the rapid increase in the average consumption of coal by every individual did not mean that wood was being less used for fuel? Referring to the question of trusts and the railways, he thought that what had been stated was a remarkable illustration of the fact that whatever was done to try to stop people from using their money in a way which turned it to the best advantage, capital invariably foiled any such attempt. When people said that it was extraordinary how small holdings in England had disappeared by being gathered up by greedy landlords, it really meant that the small holdings did not pay. It might be that at present a way was being found by which they would pay, namely, by co-operation among small holders, but as long as small holdings did not pay they would necessarily disappear. People might be stopped from co-operating, but if they were prevented from co-operating they would naturally combine. In this country a more elastic system prevailed with regard to railways. Parliamentary committees endeavoured to ensure that there should be a certain amount of competition, but that this competition should not be excessive. They had not always been entirely successful; there had been a tendency to very expensive competition, and now the railways were beginning to combine, and there was a good deal of jealousy on the part of the public as to their combination. Whether it would result in the acquisition of the railways by the State was a matter for the future to decide, but he entirely agreed with the author that the voting question was a very serious element in the matter, and that though it might be possible to nationalise railways in England, as in Germany, in the United States the enormous extent of the railways made it practically impossible.

The CHAIRMAN said Lord Sanderson had pointed out that Englishmen ought to be proud of the fact that the nation which had done the colossal things to which the author had referred that night, had sprung from our own stock. He (the Chairman) thought this country might also not only be proud of that fact, but that Americans spoke its language, followed its laws, and had very much the same ideals; and also of the fact that Great Britain had some share at the beginning in helping the United States towards their present development. The author had pointed out that at the time of the negotiation of the treaty of peace, at the end of the revolutionary war, Great Britain behaved to the new Republic, not in a niggardly or grudging fashion, but in the most broad-minded way. That was a very wise thing to do, and it had a very great effect towards helping the development of the United States. Great Britain put an immense tract of country at the disposal of the United States, which the latter might not have otherwise had. He thought that was a thing which was a legitimate object of satisfaction and pride to this country. He had been reading the other day an essay by Mr. Choate, the late American Ambassador in London, one of the best of the many good men the American nation had sent over here, and that gentleman used the phrase that this country's conduct in the negotiations which ended that war "was wise, moderate, and statesmanlike." The author had said that the United States would prove to be a great rival to Great Britain in the future. He (the Chairman) had no doubt that would be the case, and he did not think Englishmen would in the least mind that being so, but he would like to say that, so far as his reading of history went, it was a mistake to say too much on that point, and that the case could very easily be overstated. Although England and the United States had had their fraternal differences, throughout the feeling between the two nations had been an extremely friendly one. It might be said that we had fought more than once; so had the English and Irish, and the English and Scotch. He would like to point out that there were three things which had always struck him as being very remarkable: the spirit in which the two peoples approached the parting of the ways—the revolutionary war; the spirit in which that war was closed by the treaty of peace; and the spirit in which the two nations had since behaved towards one another. He thought it was very remarkable that when the war broke out it was extremely unpopular in this country, as everybody who read the history of the times knew. One would find, if one read Trevelyan, for instance, that it was exceedingly difficult to get the people of Great Britain to join in the war against the United States, and it was one of the curious ironies of history that the employment in that war of foreign troops—Hessians as they were called—which caused great bitterness on the other side of the water, was due to the fact that Englishmen would not enlist to fight against their kinsmen. Trevelyan pointed out that the man who was at the head of the army, Lord Amherst, and the man who was at the head of the navy, Keppel, refused to serve against the colonists. The great Pitt himself had a son who had just gone into the army, and when the war broke out Pitt withdrew him from the army. All that was not want of patriotism; because, before that revolutionary war, and also just afterwards—twenty years in each case—this country had great wars with foreigners, and then Great Britain poured out her blood and her treasure like water. Against America, however,

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people would not enlist, and the King had to get Hessians. There was a good deal of the same feeling on the other side. The greatest diplomatist America ever had produced—Benjamin Franklin—was as proud of the British Empire as anybody, and did his utmost to prevent its disruption; and he (the Chairman) had not the slightest doubt that George Washington drew the sword against his old comrades in arms with just as much reluctance and sorrow as, eighty years later, Robert Lee drew his in favour of his own State, Virginia, against the United States. Since the treaty of peace was signed, this country and the United States had had their differences, but it was a remarkable fact that for nearly 100 years there had been no fighting between them. He would point out that that immense borderline which separated the United States from Canada, 3,500 miles in length, was not bristling with forts and bayonets and soldiers from end to end. Nothing of that sort was to be seen—no sign of mutual distrust or hostility whatever. That was a remarkable sign of the general feeling which had existed between this country and the United States ever since 1814. Such facts were very remarkable, and ought to make Englishmen feel that they regarded that great development not in the least with any feeling of jealousy, but, on the contrary, with feelings of deepest sympathy and greatest possible pleasure.

A vote of thanks to the author for his interesting paper was then put and carried unanimously.

Dr. Douglas, in reply to Lord Sanderson's question with regard to coal consumption, said he did not think the consumption of wood for domestic fuel was greatly decreasing, because if the coal consumption and the railroad traffic of the United States in any given district were taken, it would be found that the coal was going to be used in industrial pursuits, and not for domestic purposes. Only a small quantity of anthracite mined in Pennsylvania was used as domestic fuel in preference to wood. With regard to railroads in the United States, there was little doubt that the Inter-State Commerce Commission had been of benefit. There was little doubt, likewise, that the general railroad Acts, under which railways could be built without special charters, had had an immense influence upon the rapidity with which railroads had been built. It was clear that that principle could not be applied in this country. As had been mentioned in the paper, Mr. Acworth had pointed out that every railroad built in the United Kingdom cost, for Parliamentary Bills, £5,000 a mile before a spike had been driven. £5,000 a mile had built a very large proportion of America's western railroads—as first constructed. They were built in the lightest kind of way to carry a light traffic over heavy grades, but they answered the purpose for which they were built—they developed the territory, and as the territory and freight developed, then the road was reconstructed from beginning to end on a totally different system and raised to the grade of a high-class standard road. But, of course, the state of affairs, which was perfectly applicable in a new and undeveloped country, was absolutely inapplicable to England.

THE TONNAGE OF LINERS.

Attention was recently directed in the *Journal* to the rapidly growing dimensions of liners, and it was observed that "it looks as if Lord Pirrie's prediction that we shall see 1,000-feet ships will soon be realised." This comment has induced Dr. Corthell to send an interesting letter, covering a copy of his report for the International Congress of Navigation (1912), on the size which should be given to maritime canals, and the probable size of ocean vessels of the future. Dr. Corthell contends that in the construction of maritime canals the necessity for size has not been adequately appreciated. The rapid increase in tonnage was not generally foreseen. The increase in the dimensions of commercial vessels has not reached its culminating point, nor is it entirely confined to liners trading from Europe to the port of New York. In Dr. Corthell's opinion, within the next thirty years there will be ocean vessels of 1,100 feet by 110 feet by 40 feet, with naturally a margin over these dimensions in the chambers of locks, and in the open sections of canals. One of the most interesting studies in connection with the dimensions of maritime canals is the development of the various plans of an inter-oceanic canal across the American isthmus and the natural development of the Suez Canal; a study that will show how little the best experts of the past appreciated the size of the ships that would use the canals. In Dr. Corthell's opinion, within a few years the Suez Canal will have to be deepened, in order to retain its traffic, to 42·6 feet at least, allowing for a draught of 39·4 feet, with corresponding width to allow for a passage, in two lines, of vessels of 25,000 tons. Note the gradual and reluctant concessions to the steamships in the matter of draught. The Suez Canal Company authorised, in 1869, 24·6 feet draught; in 1890, 25·5 feet; in 1898 it widened the Canal from 72 feet to 121 feet; in 1902, 26·2 feet draught; in 1906, 26·3 feet; in 1908 the Canal was deepened to 31·2 feet; and 28 feet was the authorised draught in January 1911. Dr. Corthell predicts that the dimensions of commercial and naval vessels will in the near future reach what now appear excessive figures, since the present average dimensions of the twenty largest commercial steamships are 28,018 gross tonnage, 725 feet length, 80 feet width, and 35 feet load draught, while in 1881, only thirty years ago, the corresponding dimensions were 4,900 tons, 460 feet, 45 feet, and 24 feet. There was not one steamer in 1880, 500 feet long, if the "Great Eastern" is excluded; the largest steamer was 5,490 gross tonnage, 488 ft. 6 ins. long, 44 ft. 2 ins. wide, and about 24 feet load draught. The largest steamer now is 50,000 gross tonnage, over 900 feet long over all, 96 feet wide, and the maximum

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draught is about 38 feet. Dr. Corthell concludes his interesting survey of steamship and canal capacity and requirements by the observation that the engineers who design, construct, and enlarge canals and ports, should realise the situation, and use their influence with the Governments of the world to build wisely and amply for the future ships of the world, both commercial and naval.

ARTS AND CRAFTS.

The Stevens Exhibition.— The opening of the Loan Collection of works by Alfred Stevens, which has been organised in connection with the presentation to the Tate Gallery of Professor Lanteri's portrait bust of the artist, and of a reproduction of the famous Dorchester House chimney-piece, is an event of real importance to all those interested in decorative art. Most people know, of course, that the Victoria and Albert Museum possesses a number of Stevens' drawings which are now very well shown, and that there are also some in the permanent collection at the Tate Gallery. But a special exhibition always gives a certain fillip to popular interest; and this one will doubtless rouse many of those who are usually quite content to know that Stevens' drawings are in London, and that they can study them at their leisure if they so desire—and therefore never take the trouble to go and look at them—to make an effort to see works which will only be visible to the general public for a couple of months. One critic, in his notice of the exhibition, has scornfully complained with reference to Stevens' work for Messrs. Hoole: "They employed our first sculptor as a designer!" as though that were a kind of crowning indignity. One can understand that a sculptor might feel it was so—and, of course, no one can help regretting that the genius of so great an artist was not recognised and appreciated during his lifetime, but the fact remains that, whatever else Stevens may have been, he was pre-eminently a designer, and a giant among designers. That much is apparent not only in his models, but in every line of his drawings. Many of the sketches shown at the Tate Gallery are so rough as to appear at first sight little more than scribbles, but one has only to look at them attentively to see how the draughtsman's first thoughts have been of the design, of the relations of the masses, of the decorative effect. Designers naturally do not all work on exactly the same method, and a cast-iron system of training in design is what everybody wants to avoid; but a careful study of Stevens' work ought to do a good deal towards showing any open-minded and intelligent person at least one of the reasons why so much of the design teaching of the present day fails to produce the desired results.

There is another point about Stevens' work which it is peculiarly interesting to note at the present moment—its individuality. Stevens was, of course, a disciple of the Renaissance; he was a classicist through and through; he had worked for nine years in Italy, and knew and loved the finest masterpieces of Italian Renaissance art, and his work makes it abundantly plain that his study of Michael Angelo was of the deepest. Indeed, it is almost impossible to imagine Stevens apart from his Italian training. And yet the man was no copyist of Italian models, but strikingly himself. It is the fashion of the present day to decry the study of old work as cramping to individuality. It is possible that without such study Stevens might have been a great artist, but his work inevitably gives the impression that without it he would never really have found himself. The old work had grown to be part of his own being, so perfectly had he assimilated it. The Dorchester House fireplace, for instance, quite evidently owes something to Michael Angelo, but it is not an imitation of the Italian master, nor the work of a mere disciple—it is an expression of the genius of Stevens himself, who was happy enough to have fallen in with the style which suited him in his youth, and who owed, not of course his genius, but his power of self-expression very largely to that fact.

The works collected at Millbank include, besides a quantity of sketches, the model for the suggested decoration of the dome of St. Paul's Cathedral, a small plaster sketch-model for the Dorchester House fireplace (which it is interesting to compare with the final version), a number of modelled designs for fire-irons, friezes, etc., a table of his design and various more finished drawings, amongst which the designs for a chalice and a tazza are perhaps the most remarkable.

The New Trophy for the Buffs.—Trophies are, artistically speaking, so often atrocities that it seems at first a far cry from the Stevens Exhibition to the new trophy for the Buffs. As a matter of fact it is nothing of the kind, for Miss F. H. Steele, who is responsible for it, is not only a pupil of Professor Lanteri, whose respect for Stevens is well known, but the modeller above all others who has a reverence for Stevens' work; and it is no reflection on her originality to say that this particular piece would not have been just what it is had that artist never lived and worked.

The trophy is presented to the officers of the 2nd Battalion of the Buffs by those officers of the battalion who served during the South African War, 1899-1902, and Miss Steele's design was chosen from amongst many others sent in for competition. Mr. Plante, of Regent Place, is the maker, but the artist has supervised the execution from start to finish, and has identified herself with the work throughout. The base, which bears on its outer rim the names of the battles in which the regiment has distinguished itself, is massive, and in a way recalls a fine old salt or tankard; at its two sides are little figure groups representing Kent (since the Buffs is a Kentish regiment) instructing her children in knowledge and in arms, behind which are swags of hops and cherries. On the second member is a spirited rendering of the dragon badge of the

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regiment and a label inscribed with its motto "veteri frondescit honore." A circular column round which are modelled in fairly high relief four figures symbolical of Courage, Endurance, Loyalty and Mercy, surmounts this member, and forms a support for the dainty little winged figure of Victory standing on tip-toe with her draperies floating behind her, which crowns the whole work. Some of the details, notably the badge, the figures round the column, and the tenderly graceful seated figures of Kent, are extremely good, but the strong point of the trophy is not so much the beauty of individual members or details as the grace and harmoniousness of the whole. The line of the composition is entirely pleasing, and the little groups at the side, instead of marring the general effect, help to steady it; much as well-schemed handles would do. Miss Steele's work is always marked by a feeling for style, and by a dignified restraint, and her latest important piece of work is no exception to the general rule; the ornament and the figures go well together; the piece is not overloaded with detail, and there are no excrescences to interfere with the main lines of the form. The execution, too, is not only good technically, but shows that the artist has been in close touch with the workmen throughout, and that the maker has spared no trouble or expense. It is encouraging to see such a really distinctive and distinguished piece of work —and also to reflect that the officers who chose it had the good taste to recognise its merit. Thanks to them, their regiment has acquired a piece of plate of which it can be justly proud.

Embroidery and Hand-Loom Weaving.—Both at the little exhibition organised by the *Englishwoman*, and held at the Maddox Street Gallery, and at the Irish Exhibition at the Royal Horticultural Hall, there was a good opportunity of seeing what women are doing in the way of embroidery and hand-loom weaving. The most interesting pieces of needlework were the two landscape panels shown by the Cuala industry. They are largely in darning, and only as much stitchery has been employed as was necessary to give the effect, but they are thoroughly satisfactory. The bare tree-trunks in the wintry scene, and the bright white flowers in the summer one, are really most expressive. It is a question whether landscapes are the best things to render in embroidery, but if they are to be done, this is certainly the way to do them. The work of the Windermere industry continues to be characterised by an uncommonly good sense of colour, and the Celtic patterns of the Dun Emer Guild are well considered and carefully worked, but the quantity of so-called "art embroidery," which is by no means as good, either in design or workmanship, as it should be, does not seem to diminish appreciably. The hand-woven stuffs, both silken and woollen, are often very pleasing in colour, and seem to suggest that those responsible for them appreciate the qualities of the materials in which they are working. Some of the simple woven patterns, too, are admirable of their kind. There was not so much lace at the Irish Exhibition as might reasonably have been expected, but some of the crochet was very satisfactory, copied from good models, and used with discrimination. It is a pity that, while a certain amount of good work is shown at the numerous little shows devoted to arts and handicrafts held before Christmas, they are always marred by one or two stalls which cheapen the whole effect of the exhibition.

EMPIRE NOTES.

Australian Railway Gauges.—For some time past the question of making the gauges of the various State railways in Australia uniform has been engaging the attention of the Commonwealth Government. It is proposed that the gauge of all the Australian railways should be the same as in this country, namely, four feet eight and a half inches. The gauge of the Queensland Railway is small, whereas that in New South Wales is four feet eight and a half inches, and that of Victoria and South Australia five feet three inches. In the event of the proposal being carried into effect, Victoria and South Australia will have to lay a third rail, but it will still be possible for these Governments to work off their old stock on the existing gauge, while through trains could be run on the four feet eight and a half inch track. A comparatively short distance of line in Queensland would have to be widened to the standard gauge in order that trains might run from Sydney to the Tweeds Heads, and the tunnels on the line to Southport on the coast will have to be made sufficiently large to accommodate trains running on the standard gauge. The new Trans-Continental Railway from Perth to Adelaide will be built with a four feet eight and a half inch gauge, thus making it possible for trains to run from Perth to Brisbane without a break.

Tin and Diamonds in Bass Straits.—The little archipelago that lies between Australia and Tasmania in the Bass Straits is coming into prominence in mining circles in Australasia. Tin in payable quantities is reported from Cape Barren Islands. Mr. H. Hawkes, well known as an authority on tin in Tasmania, has visited the Islands and reports that a Tasmanian syndicate under the management of Mr. E. Connors is cutting a prospecting tail race in splendid looking tin ground. Other prospectors also, have secured promising claims, and on the lease being worked by Mr. John Fisher, on behalf of Mr. A. Ross, very rich tin has already been obtained. During one week on this property two men were able to mine half a ton. Mr. Hawkes further reports that on other blocks good prospects are being obtained, but these properties are at present handicapped by want of water. Alluvial tin can be got on the beach. Mr. Hawkes speaks very optimistically about the mineral developments of the hills at the back, though he draws attention to the scarcity of fuel for generating steam. He

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suggests that a geological survey would prove of considerable value, and believes that the fuel question could be solved by electric power or other agencies not requiring a large supply of firing, though fuel can be obtained if a route is surveyed and a roadway cut. Referring to Flinders Island, Mr. Hawkes expresses surprise that the valuable alluvial at Pat's River, the property of the Straits Islands Pastoralists' Association, is lying idle. He affirms that dredging would prove a highly remunerative undertaking, and thinks that it only requires some syndicate with sufficient capital to operate on a proper scale to make this claim a great financial success. Recent prospecting bores seem more than to bear out his opinion. At Tanner's Bay Mr. Doherty has been successful in inducing Melbourne mining people to interest themselves in his venture. Another item of interest concerning the Tanner's Bay district is the reported discovery of diamonds. If this report is true, and diamonds in payable quantities are found, a period of prosperity for the Bass Straits is bound to result.

Aerial Railway for Table Mountain.—For many years past the public of Cape Town have been anxious to have a railway constructed up Table Mountain, and it is interesting to note that during the last month the Cape Town City Council has received a letter from a large firm of contractors, applying for a concession to enable them to construct an aerial railway up the mountain. The contractors suggest that the Council should grant them permission to construct the necessary works on municipal land over the route, which will be either from the neighbourhood of Orangezicht or Rocklands, as determined after the necessary survey has been made. They will also require a sufficient area of ground at the commencement of the line for station and engineer's quarters. Further, they have asked the Council to grant them its assistance to have a half-way house built at the foot of the famous gorge, where a suitable restaurant will have to be erected, and also an hotel on the top of the mountain. The power for the railway will be electric, but, before anything definite can be done, it will be necessary for the Town Council to inform the promoters on what conditions and at what rate they will be prepared to supply current. It is hoped that this agreement will meet with general approval, as it will thereby induce many visitors to Cape Town to go up the mountain, which, at present, can only be accomplished by a tedious climb.

Unusual Weather in South Africa.—East Transvaal has provided an extremely interesting meteorological phenomenon during the month of September. In the first week, quite winter conditions were experienced, with eight and ten degrees of frost every night. A fortnight later the hottest summer conditions prevailed, and the thermometer rose to between 89° and 92° in the shade, day after day, and the nights proved correspondingly close and hot. Statistics showed that the month produced the highest mean maximum shade temperature (80°), and the lowest mean minimum temperature (40·8°), recorded in ten years. Another strange occurrence was the total absence of rain, which, likewise, has never happened during a similar period.

The Canadian Census.—The preliminary statement of the Canadian census is now in the hands of the Dominion Government. Although the figures shown are to be revised, it is generally expected that they indicate very nearly the population of the Dominion. A great deal of disappointment is being felt by those who have imagined that the population would show a much larger increase than it does. The population at the moment is put down at 7,000,000, whereas it was anticipated that it would have been nearer 8,000,000. The population of Quebec is but little over 2,900,000. As each census is taken, a redistribution of seats in the Assembly becomes necessary. It is foreshadowed that, as a result of this, Nova Scotia, New Brunswick, and Prince Edward Island will each lose a member, and Ontario two or three, while the western provinces will gain from twelve to sixteen members. The representation, however, largely depends upon the relative losses of city and rural constituencies.

Canada and the West Indies.—Sir William Grey-Wilson, Governor of the Bahamas, has been on a visit to the Dominion of Canada. Whilst there he took the opportunity of advocating a political union between Canada and the West Indian colonies. The proposal has excited considerable interest throughout the Dominion, but in this country, so far, there appears to have been no pronounced expression of opinion on the subject. Sir William is convinced that such a union would be advantageous to British interests, both in Canada and in the islands. He does not, however, advocate the transfer of the islands *en bloc* to the Canadian Government, but is of opinion that an experiment should be made whereby parts of the Indies can be brought under the rule of Canada. At the back of the suggestion is the question of tariffs, but that need not necessarily affect its political advantage or disadvantage, which must be a matter of Imperial concern. On this point Sir William seems to have no doubt, as he says: "It would be a great thing from an Imperial point of view, tending to a more complete and beneficial relation between the colonies themselves and the Empire."

French Banking Enterprise in Montreal.—French capitalists are realising the large openings for investment in Canada, and consequently a new bank, known as the Banque Internationale, has been opened in Paris and Montreal. The opening in Montreal, following the granting of a certificate by the Treasury Department in Ottawa, was under most favourable circumstances, deposits to the

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amount of £23,200 being placed with the bank on the first day of business. Business is being carried on at the present moment in the Standard building on St. James Street, but immediate steps will be taken to secure more commodious quarters. Branch offices will be opened at an early date in Quebec, Toronto, and Three Rivers, while one or two others will also be opened in the outlying districts round Montreal. The bank starts with a paid-up capital of £2,055,000, the major part of which has been subscribed in Paris. It is anticipated that it will encourage a constant flow of French capital into Canadian enterprises.

Industrial Expansion in Canada.—Mr. J. Norton Griffiths, M.P., whose knowledge of Canadian affairs is perhaps wider than that of any other member of the British Parliament, recently made an interesting and important statement on the subject of Canadian industrialism. He said: "There is hardly a single branch of trade in this country which could not be fully established in Canada under experienced management, and to reap a full share of business firms would be wise at the outset in sending out their own men and partly-manufactured materials, until such industries attained full development. United States business men are doing this all the time, and the industries which have been started lately in Canada have proved a commercial success in every case. There can be no doubt that the present is the time for action to be taken, for without making invidious comparisons between British and United States business methods, the Americans have shown keen aptitude in taking advantage of numerous openings in the Dominion. The best evidence of the widespread prosperity and the splendid openings that exist is that of personal investigation, and for this purpose special facilities are granted to manufacturers by the Government, and assistance rendered by local boards of trade and bank managers."

NOTES ON BOOKS.

MERCANTILE LAW. By D. F. de l'Hoste Ranking, M.A., LL.D., Ernest Evan Spicer, F.C.A., and Ernest C. Pegler, F.C.A. London: H. Foulks Lynch & Co. 10*s*. 6*d*. net.

Mercantile law is derived very largely from the customs which have gradually grown up among merchants, and which have been from time to time ratified by the decisions of the courts of law. The courts, in settling these cases, have proceeded on the principle that, "with reference to transactions in the different departments of trade, courts of law, in giving effect to the contracts and dealings of the parties, will assume that the latter have dealt with one another on the footing of any custom or usage prevailing generally in the particular department. By this process what was before usage only, unsanctioned by legal decision, has become engrafted upon, or incorporated into, the common law, and may thus be said to form part of it." From the manner of its growth it will be seen that mercantile law is an exceedingly technical business, complicated in each case by the usages of the trade concerned. The present volume gives a lucid and interesting account of it in eleven chapters, dealing with contracts, agency, the sale of goods, negotiable instruments, security and guarantees, insurance, bailments, carriage, merchant shipping, securities, and miscellaneous matters. Each chapter is prefaced by a synopsis, and a very large number of cases are quoted in illustration of the text. The book appears to be an excellent introduction to a very difficult subject, and should prove of much service to those who are beginning to study it.

GENERAL NOTES.

UTOCOLOR-PAPER. — According to a note in *Nature*, the Société Anonyme Utocolor of La Garenne-Colombes, Paris, is now introducing an improved paper under the name of "Utocolor-paper," which has been perfected by Dr. J. H. Smith's investigations, and which, when exposed under a coloured transparency, furnishes a coloured copy of the transparency. The new paper is stated to be much more rapid than the old, and it is free from the odour of anethol, the sensitiser previously employed. The gelatinous coating of the paper contains three dyes, red, yellow, and blue, which are bleached by exposure to light; and if a coloured light is employed, the dye, or mixture of dyes, that matches the colour of the light survives longer than the other dyes, which absorb the light, and therefore a coloured original is reproduced. The exposure necessary to copy an autochrome is about two hours of direct sunshine, or several hours of good diffused light and one hour of sunshine to finish it. Coloured light-filters are supplied, and one or both of them are placed over the frame during the exposure. They serve to absorb the ultra-violet and adjust the comparative colour intensities. The paper after exposure is desensitised, or "fixed," and the prints may then be kept in a feebly-lighted room for a considerable time without obvious change; and in the dark, as in an album, they may be regarded as practically permanent.

THE INSTITUTE OF METALS. — The London meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., on Tuesday, January 16th, and Wednesday, January 17th, 1912. The meeting will commence on Tuesday afternoon, when the President-Designate (Professor W. Gowland, F.R.S.) will deliver his inaugural address on the subject of "Copper and its Alloys in Early Times." Wednesday, January 17th, will be devoted to the reading and discussion of papers,

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amongst which may be mentioned the following:—"Properties of Certain Copper Alloys at High Temperatures," by G. D. Bengough, M.A.; "Further Experiments on the Inversion at 470° C. in Copper-Zinc Alloys," by Professor H. C. H. Carpenter, M.A., Ph.D.; "The Influence of Oxygen on Copper containing Arsenic or Antimony," by R. H. Greaves; "The Nomenclature of Alloys," by Dr. W. Rosenhain, B.A.; "Poisoned Brass, and its Behaviour when Heated in Vacuo," by Professor T. Turner, M.Sc.; and a paper by Dr. Carl Benedicks, of the University of Stockholm, dealing with some novel experimente on a zinc-antimony alloy.

International Congress of Applied Chemistry.—The eighth International Congress of Applied Chemistry will be held from September 4th to 12th, 1912. The opening meeting will take place at Washington, and the other meetings, business and scientific, at New York. The Congress will be opened by the President of the United States. An invitation has been issued by the officers and members of the executive committee to members of the Royal Society of Arts to attend the Congress, and those desiring further particulars should apply to Dr. Bernhard C. Hesse, Secretary of the Congress, 25, Broad Street, New York.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

November 29.—A. E. Berriman, "The Efficiency of the Aeroplane." Dugald Clerk, F.R.S., will preside.

December 6.—J. A. J. de Villiers, "British Guiana and its Founder, Storm Van 's Gravesande." Lord Reay, G.C.S.I., G.C.I.E., LL.D., will preside.

December 13.—W. Yorath Lewis, M.Am. Soc.M.E., A.M.I.Mech.E., Assoc.M.I.E.E., "Continuous Service in Passenger Transportation."

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

December 14.—J. Travers Jenkins, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal." Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Professor Vivian B. Lewes, "The Carbonisation of Coal." Four Lectures.

Syllabus.

Lecture I.—November 27.—*The Composition of Coal.*—Existing theories on the composition of coal and the chemistry of its formation—Humus and resin compounds found in lignites, and the action of heat upon them—The classification of coals, and the effect of composition on the products of decomposition by heat—Coking and non-coking coals.

Lecture II.—December 4.—*The Methods Employed in the Destructive Distillation of Coal.*—The changes which have taken place during the last century in the forms and settings of gas retorts—The developments of the last ten years and present position of the gas industry—The coke industry and the gradual development of the modern recovery plant—The influence of the retort or oven on the carbonisation.

Lecture III.—December 11.—*The Thermal Conditions existing during the Carbonisation of Coal.*—The heat of formation of coal—The work of Euchene, Mahler, and others—The cause of the endothermic nature of some coals—The thermal value of the reactions taking place in the retort—The losses of heat in a retort setting—The transmission of heat through the retort and charge—The effect of temperature and travel on the primary products of decomposition—The temperatures existing in retorts and ovens—Small charges and full charges—The influences which lead to improvement in the products from full charges, chamber and vertical retorts.

Lecture IV.—December 18.—*The Possible Improvements in Carbonisation.*—The aims of the gas manager and coke producer—Experiments on low temperature distillation and their teaching—The rivalry existing between fully-charged retorts, vertical retorts, recovery ovens, and chamber carbonisation—The intermittent vertical retort *versus* the continuous vertical systems—The Settle-Padfield, Duckham-Woodall, and Glover-West processes—The ideals of carbonisation—The volume of gas due to primary and secondary reactions—The gasification of tar—The limitations of volume and quality of gas—The ends to keep in view in devising new processes of carbonisation.

Papers to be read after Christmas:—

Cecil Thomas, "Gem Engraving."

F. Martin Duncan, "The Work of the Marine Biological Association."

H. A. Roberts, M.A., "The Relations of Science to Commerce and Industry."

John Nisbet, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

Frank Warner, "Silk."

Charles C. Allom, "The Development of Artistic Skill in the Applied Arts."

Cyril Davenport, "Illuminated MSS."

Ernest Kilburn Scott, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

Charles Bright, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

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HAROLD COX, "The Interdependence of Morals and Economics."

PROFESSOR G. W. OSBORN HOWE, "Recent Progress in Radio-Telegraphy."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Stage Illusion."

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

WALTER SAISE, D.Sc., M.Inst.C.E., F.G.S., "The Coal Industry and Collier Population of Bengal."

NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

ALAN BURGOYNE, M.P., "Colonial Vine Culture."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 18, February 8, March 14, April 25, May 16.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 30, February 27, March 26, May 7.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean-Waves, Sea-Beaches, and Sandbanks." Two Lectures.

January 22, 29.

LOUDON M. DOUGLAS, "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "Hand-Loom Weaving." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

JUVENILE LECTURES.

Wednesday afternoons, at 5 o'clock:—

CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." Two Lectures.

January 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "The Carbonisation of Coal. Lecture I.—The Composition of Coal."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. J. J. Dones's paper, "The Development of Building Land."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Mr. G. J. Lidstone, "A New Method of Approximating to the Values of Last Survivor Annuities on two or more lives, and to the Values of Joint Life Annuities when the advantages of Makeham's Law are not available."

London Institution, Finsbury-circus, E.C., 5 p.m. Dr. A. Hill, "Man under the Microscope."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. A. T. Bolton, "Thoughts on Jacobean Architecture."

TUESDAY, NOVEMBER 28...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. Mr. G. P. Gooch, "Histories and Historians of Civilisation."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. R. T. Smith, "Electric Lighting of Railway Trains: the Brake-Vehicle Method."

Hungarian Society, at the Galleries of the Royal Society of British Artists, Suffolk-street, S.W., 8.30 p.m. Mr. W. H. Shrubsole, "Picturesque Hungary."

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. H. Roger-Smith, "Rambles around Zermatt and Arolla."

Anthropological, 50, Great Russell-street, W.C., 8.15 p.m. Captain B. T. Somerville, "Pre-historic Monuments in the Outer Hebrides and their Astronomical Significance."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mrs. Mary Gaunt, "British and German Influence in West Africa."

WEDNESDAY, NOVEMBER 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. E. Berriman, "The Efficiency of the Aeroplane."

African Society, Trocadero Restaurant, Shaftesbury-avenue, W., 9 p.m. 1. Sir George Denton, "Twenty-three Years in Lagos and the Gambia." 2. Sir Henry Gallwey, "Nigeria."

United Service Institution, Whitehall, S.W., 3 p.m. Baron Roenne, "Protection for Warships against Torpedoes."

THURSDAY, NOVEMBER 30...Men of Sussex Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. A. Martin, "The Downs and Dew-Ponds of Sussex."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

London Institution, Finsbury-circus, E.C., 6 p.m. Dr. H. R. Mill, "Storm Rains."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. F. Martin Duncan, "Romance of Marine Biology."

Auctioneers, 34, Russell-square, W.C., 7.45 p.m. Mr. E. Evans, "The Finance (1909–10) Act, 1910—The Land Taxes."

FRIDAY, DECEMBER 1...British Empire Naturalists' Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. Buckland, "The Value of Birds to Man."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. J. J. Lassen, "Modern Methods of Water Softening and Purification."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Messrs. James and Will Legg, "Brake-Lining Coefficients of Friction."

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Journal of the Royal Society of Arts.

No. 3,080. VOL. LX.

FRIDAY, DECEMBER 1, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 4th, 8 p.m. (Cantor Lecture.) Professor VIVIAN B. LEWES, "The Carbonisation of Coal." (Lecture II.)

WEDNESDAY, DECEMBER 6th, 8 p.m. (Ordinary Meeting.) J. A. J. DE VILLIERS, "British Guiana and its Founder—Storm van 's Gravesande." LORD REAY, G.C.S.I., G.C.I.E., LL.D., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "THE CARBONISATION OF COAL."

On Monday evening, November 27th, Professor VIVIAN B. LEWES delivered the first lecture of his course on "The Carbonisation of Coal."

The lectures will be published in the *Journal* during the Christmas recess.

CANTOR LECTURES ON "ROCK CRYSTAL."

The Cantor Lectures on "Rock Crystal: its Structure and Uses," by ALFRED E. H. TUTTON, M.A., D.Sc., F.R.S., have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 3rd and 10th, at 5 o'clock, by CHARLES VERNON BOYS, F.R.S., on "Soap Bubbles."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who require tickets for the course are requested to apply for them at once.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday afternoon, November 29th. Present:—

Sir William Lee-Warner, G.C.S.I. (Chairman of the Committee), Sir M. M. Bhownaggree, K.C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., William Coldstream, B.A., Sir Steyning William Edgerley, K.C.V.O., C.I.E., Sir Frederic W. R. Fryer, K.C.S.I., Colonel Sir Thomas Hungerford Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., Sir James Digges La Touche, K.C.S.I., Henry Luttman-Johnson, R. A. Leslie Moore, Sir Patrick Playfair, C.I.E., Sir James Wilson, K.C.S.I., Colonel Charles Edward Yate, C.S.I., C.M.G., M.P., with S. Digby, C.I.E. (Secretary of the Section), and G. K. Menzies, M.A. (Assistant Secretary of the Society).

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, November 29th, 1911; DUGALD CLERK, F.R.S., M.Inst.C.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Costello, John Francis, B.A., Camp, Sholapur, Deccan, India.

de Villamil, Lieut.-Colonel Richard, Carlisle Lodge, Rickmansworth.

Foord, Charlton Willoughby Hougham, 23, Kitson-road, Barnes, S.W.

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Harrop, Edwin, 109–119, Rosebery-avenue, E.C.

Heath, Dudley, Pembroke Lodge, Winchmore-hill, N.

Huntsman, Henry William Tite, Rions, Northwick Park-road, Harrow, Middlesex.

Morgan, George, I.S.O., Downings, Wallington, Surrey.

Stout, Arthur Purdy, 574, Madison-avenue, New York City, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Angel, Robert John, M.Inst.C.E., A.R.I.B.A., Town Hall, Spa-road, S.E.

Baildon, Arthur Edward, Yeo Cottage, 6, Yeo-street, Yeoville, Johannesburg, South Africa.

Bain, Professor Samuel M., University of Tennessee, Knoxville, Tennessee, U.S.A.

Banganapalle, The Nawab of (Nawab Saiyid Ghulam Ali Khan Bahadur), Banganapalle, India.

Beanes, Fred. E. V., 4, Morden-road, Blackheath, S.E.

Benson, His Honour Judge William Denman, 10, William-street, Lowndes-square, S.W.

Bhattacharya, Professor Saratchandra, M.A., F.C.S., St. Columba's College, Hazaribagh, Bengal, India.

Black, Professor Ebenezer Charles, LL.D., 50, Kirkland-street, Boston, Mass., U.S.A.

Bray, Henry Freer, 12, Shinryudo-cho, Azabu, Tokyo, Japan.

Bremner, Alexander, 38, New Broad-street, E.C.

Bright, Alfred Ernest, 34, Queen-street, Melbourne, Australia.

Burnside, William, Assoc.M.Inst.C.E., c/o Messrs. MacBride, McGrouther & Co., 149, West George-street, Glasgow.

Butcher, Miss Anna Deane, c/o Dr. Bailey, Featherstone Hall, Southall, Middlesex.

Canjee, Sheriff D., 13, Cuffe-parade, Bombay, India.

Cantlie, James, M.A., M.B., F.R.C.S., D.P.H., 140, Harley-street, W.

Chowdhury, Brajendra Kishore Roy, Gouripore, Mymensingh, India.

Clare, George Herbert, P.O. Box 1194, Saskatoon, Saskatchewan, Canada.

Cocks, Robert Macfarlane, 24, Oakwood-court Kensington, W.

Coen, Giorgio Silvio, San Polo, Palasso Bernardo 1978, Venice, Italy.

Cole, Harold Linter, c/o Messrs. King, King & Co., Bombay, India.

Corfe, Right Rev. Bishop Charles John, D.D., Church House, Dean's Yard, Westminster, S.W.

Cross, Malcolm, 1, Devonshire-gardens, Glasgow, W., and Carlton House, 11D, Regent-street, W.

Daniel, Captain F., Penang Pilot Association, Government Buildings, Penang, Straits Settlements.

Datta, Aswini Kumar, Barisal, Eastern Bengal and Assam, India.

Dickson, Charles Allan, Kadarma, E.I.R., India.

Douglas, Greville, 27, Wilton-crescent, S.W.

Dukoff-Gordon, Ronald, B.A., Germiston, Transvaal, South Africa.

Dutt, Ajit Kumar, Dilkusha, Bhowanipore, Calcutta, India.

Edgley, Sydney William, F.C.P.A., 20, St. George's House, 73, St. George's-street, Cape Town, and Rosebank, Cape Town, South Africa.

Ellahie, Abdur Raheen Buksh, 10, Colootolah-street, Calcutta, India.

Elliott, Dawson K., 35, Kennedy-street, Winnipeg, Manitoba, Canada.

Fitz-Gibbon, William Guerin, B.A., The China Mutual Life Assurance Co., Limited, Hangchow City, Chekiang Province, China.

Fletcher, A. Byers, D.D.S., 9, Park Mansions, Knightsbridge, S.W.

Gee, William John, 48, Kingsmead-road, Tulse-hill, S.W.

Gupte, Rai Bahadur B.A., F.Z.S., Indian Museum, Calcutta, India.

Hajime, Councillor Hodo, Kiobashi, Tokyo, Japan.

Hamilton, Professor George Hall, B.A., 12, Grove End-road, St. John's-wood, N.W.; and Bellevue College, Bellevue, Nebraska, U.S.A.

Hate, Professor Vinayak Nanabhai, B.Sc., Girgaon Back-road, Girgaon, Bombay, India.

Hewlett, William George, Box 3492, Johannesburg, South Africa.

Jackson, B. Leslie, A.R.C.A., Croft Lodge, The Park, Newark-on-Trent.

Jameson, Percy R., Taylor Instrument Company, Rochester, New York, U.S.A.

Jhaveri, Krishnalal Mohanlal, Girgaon Post Office, Bombay, India.

Lloyd, Charles Sidney FitzRoy, Custom House, Shanghai, China.

MacMahon, Major Percy Alexander, R.A., Sc.D., LL.D., F.R.S., 27, Evelyn Mansions, Carlisle-place, S.W.

McMorran, Thomas, 101, Leadenhall-street, E.C.

Martini, Dr. Erich, Wiesbadenerstrasse, 5, Friedenau, Berlin W., Germany.

Mawson, C. O. Sylvester, P.O. Box 886, Springfield, Mass., U.S.A.

Meyer, Ralph A., B.Sc., Box 92, South Porcupine, Ontario, Canada.

Misra, Syama Behari, B.A., Jodhpur, India.

Monsbourgh, Alan G., A.R.I.B.A.; Sauers Buildings, Market and Loveday Streets, Johannesburg, South Africa.

Morley, Geoffrey Hope, 2, Grosvenor-square, W.

Morrill, George Pillsbury, Ph.B., M.Am.Soc.C.E., Sagua la Grande, Cuba.

Mottram, Arthur H., Tin Areas of Nigeria Co., Limited, P.O. Naraguta, Bauchi, N. Nigeria, West Africa.

Munson, Professor John P., M.D., 706, North Anderson-street, Ellensburg, Washington, U.S.A.

Nilambur, The Raja of, Nilambur, Malabar, India.

Pierret, Christian, 39, Lombard-street, E.C.

Pillai, P. Kesava Pillai Padmanabha, Trivandrum, Travancore, India.

Ram, Rai Bahadur T. Chaju, Dhar State, Central India.

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Rivaz, Sir Charles Montgomery, K.C.S.I., 41, Hill-street, Berkeley-square, W.
Scott, G. Hall, M.Inst.C.E., Royal Societies Club, St. James's-street, S.W.
Seaman, Major Louis Livingstone, M.D., 247, Fifth-avenue, New York City, U.S.A.
Singer, Paul, 22, Rue Richer, Paris, France.
Standen, Bertram Prior, C.I.E., I.C.S., The Holt, Chorley Wood, Herts, and Nagpur, Central Provinces, India.
Stewart, Arthur James, 41-45, Mutual Buildings, Johannesburg, South Africa.
Stikeman, Hon. William R., Messrs. Gillanders, Arbuthnot & Co., Rangoon, Burma.
Svamin, Sriman Alkondavilli Govindacharya, C.E., M.R.A.S., 1050 (Veda-Griham), Viceroy-road, Mysore City, India.
Thomas, William, M.Inst.M.E., Glanffrwd House, Cemetery-road, Porth, Glamorgan.
Thomson, P. A., 8, Crosby-square, E.C.
Turner, Captain Frederick Arthur, 73, Drewstead-road, Streatham Hill, S.W.
Venning, Captain Francis Esmond Wingate, Pyawbwe, Upper Burma.
Watson, Francis Dashwood, 62, Upper Richmond-road, Putney, S.W.
Watt, James, 24, Rothesay-terrace, Edinburgh.
White, Henry E., Dunedin, New Zealand.
Yule, Robert Andrew Alexander, Braeside, Fountain-road, Dulwich Wood Park, S.E.

The paper read was—

AEROPLANE EFFICIENCY.

By Algernon E. Berriman, M.Inst.A.E.,
Technical Editor of *Flight*.

Efficiency in an aeroplane, as in any other machine, is the determining factor in its capacity to do big work on a limited supply of fuel. Long journeys and flights of extended duration are limited by this, quite apart from any consideration as to the stability of the machine, the skill of the pilot, or the behaviour of the weather.

From land to land across the Atlantic Ocean, the shortest distance is some 1,700 miles, which would occupy about twenty-eight hours on a machine averaging 60 miles an hour. Fuel is being consumed during the whole of this time at a minimum rate of ·65 pints of petrol per horse-power hour, whence at least (28 × ·65 = 18·2) pints would be needed for every horse-power developed by the engine employed. This quantity would weigh, for petrol of ·7 specific gravity, approximately 15 lbs.

In flight an engine works at full power all the time, so there is no discount on the above figure when it is multiplied by the power of the engine in order to obtain the total quantity of fuel consumed.

The engine itself would weigh at least 3 lbs. per horse-power, whence the power-plant alone represents (15 + 3 = 18 lbs.) per horse-power as a minimum for the journey. The engine that would carry itself across the Atlantic must, therefore, be capable of supporting 18 lbs., in flight at 60 miles per hour, per horse-power developed.

One horse-power is equivalent to 6·3 lbs. thrust at 60 miles per hour, and the ratio 6·3 to 18 = ·35, represents the minimum thrust-lift ratio, "efficiency," or, as I prefer to call it, "coefficient of flight," for this imaginary system in which the power-plant is supposed to be flying without wings or propeller.

Directly the aeroplane and pilot are introduced into the calculation, this minimum value is altered considerably, for however light you may conceive it possible to build a machine, the man, at any rate, will weigh 150 lbs. if he is a normal specimen of humanity. This weight and the weight of the machine are fixed quantities, and their influence on the efficiency factor is greater the smaller the engine, for the more powerful the motor the less per horse-power is the increment that they represent.

For example, suppose the aeroplane and the pilot weigh 1,000 lbs. while the engine is 100 horse-power; their increment represents 10 lbs. per horse-power to the absolute minimum of 18 lbs. per horse-power in flight at 60 miles per hour, and thereby alters the coefficient of flight to ·225.

Alternatively, if only 50 horse-power is employed, the efficiency ratio is raised to 38 lbs. per horse-power, which is equivalent to a coefficient of flight of ·166. Thus, the less powerful the engine the more efficient must be the aeroplane as a whole, consequently *the chances* of building a machine that will do the job *increase with the power* of the engine, provided always that such an engine is itself as economical and light per horse-power as one of lower power.

The extra total weight of fuel required for the larger engine only affects the question in so far as it may adversely influence the design of the aeroplane proper, on which, of course, it must be carried. So far as it represents dead weight, it is proportional to the power developed, and, therefore, it is immaterial whether there is much of it or little.

If there is a difference in fuel economy between one engine and another, the length of the journey determines whether this difference is important or not, for the effective difference in weight per

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horse-power brought about thereby is ascertained by multiplying the difference in the rate of fuel consumption by *time.*

If, on the other hand, the difference between two engines is solely one of weight per horse-power, then the effective importance is unin-

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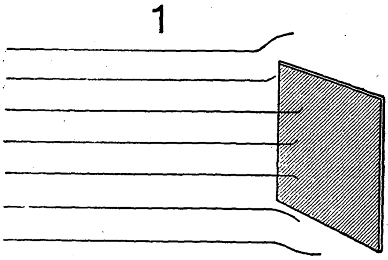


NORMAL PRESSURE
$=\cdot 003\,V^2$

fluenced by the nature of the flight. Also it is generally small by comparison with the increment represented by the weight of the aeroplane and pilot, as explained above. For example, if the engine weighed 4 lbs. per horse-power, instead of 3 lbs. per horse-power, this would only mean a difference of 1 lb. per horse-power, whereas the aeroplane and pilot represent an increment of at least 5 lbs. per horse-power with a 100 horse-power engine.

For the sake of argument, let us assume that the engine develops 100 horse-power and works under the above conditions. It will require ($100 \times 15 = 1{,}500$) lbs. of fuel for the journey. This quantity of petrol would occupy (at 43·4 lbs. per cubic foot) nearly 35 cubic feet, and could be carried in a cylindrical tank 2·5 ft. in diameter by 7 ft. long. This investigation is important; it shows whether it is practicable to carry the initial quantity of fuel that must be put on board before the start of a long flight. Also it is some indication as to the strength and size of the aeroplane that would be required to carry the fuel in addition to the pilot and any other extra load.

It should interest those who have not previously studied this aspect of flight to observe that some fairly tangible conception of the problem is afforded by such a simple application of first principles in mechanics. None of the above deductions have been founded on any special knowledge of the laws of flight; it is simply and purely an armchair analysis of the fundamental situation, for all that has been done is to say what the coefficient of flight must be if a certain weight is to be sustained at a certain speed by a certain power.

As the conception of a self-supported mass in continuous horizontal motion is not elsewhere presented by any ordinary problem in mechanical science, it often happens that even the trained mind fails to appreciate this fundamental simplicity of the case. When a definite weight is known to be supported in horizontal motion at a definite speed by the exertion of an engine of definite power, then these very data themselves establish the ratio of thrust to lift, that is, the measure of an aeroplane's "efficiency," which I have otherwise expressed by the more appropriate term "coefficient of flight."

To know that a certain coefficient of flight is obtainable is one thing, to know how to obtain it is another. Investigation of this side of the question leads on to a study of resistance to motion through the air and the lift of a wing in flight.

First, as to resistance generally. This is primarily of two kinds; in one part it is due to normal pressure caused by the wind striking against the face of a flat surface (Fig. 1), in the other it is due to "skin friction" caused by the wind rubbing against the sides of a plate that is moving edge on (Fig. 2).

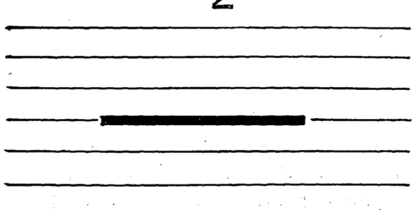
Dr. Stanton, of the National Physical Laboratory, also various other authorities, have experimentally established an accepted formula for such normal pressure resistance in the expression $R = \cdot 003V^2$, where R is in pounds per square foot of area facing the wind and V is in miles per hour.

In America, Dr. A. F. Zahm has experimentally provided a formula that has not been generally accepted, although one of the few that exist, in the expression

$$R = \cdot 0000316V^{1\cdot 85}l^{0\cdot 93}$$

(where R = resistance of double surface per foot

2



SKIN FRICTION
$=\cdot 000018\,V^2$

of span, l = chord of surface). This formula may be approximated for aeroplane wings, within the ordinary limits of modern flight speeds, by the simplified expression $R = \cdot 000018V^2$ (Fig. 3). And, as the expression itself is in doubt, there is little object in being particular as to accuracy

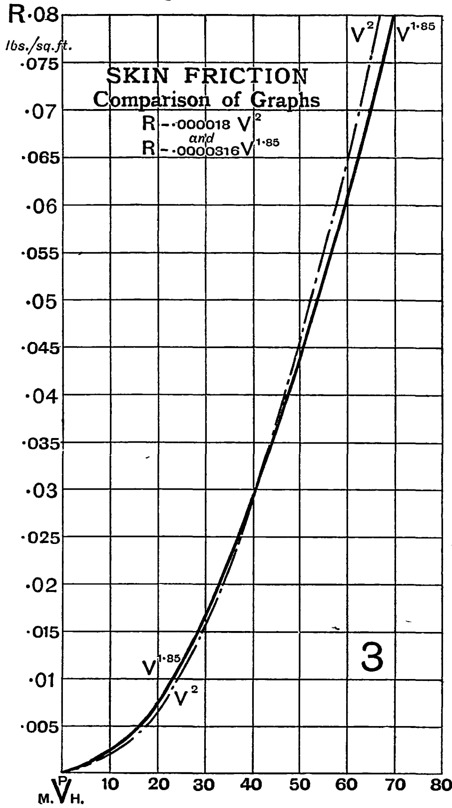
in detail at the moment. In this expression, R represents the resistance per unit of *double* surface moving as a plate edge on to the wind. When the surfaces are separated, as in the formation of a box or casing, where they would be measured separately, the coefficient in the above formula is halved to make it applicable to the single surface or external area.

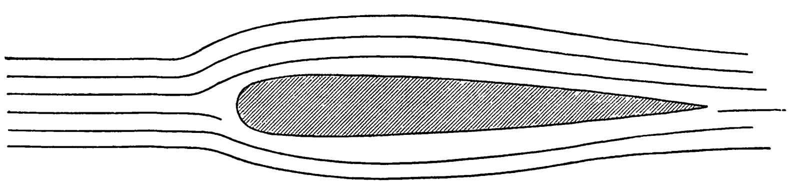
The important point to observe is that the relationship between skin friction and normal pressure is represented by the ratio of 1 to, approximately, 300. In other words, you may use 300 square feet of edge on surface to enclose 1 square foot of normal area, if you can ensure that this covering body is truly edge on in effect.

Bodies of streamline form (Fig. 4), as understood in naval architecture and in fluid dynamics generally, are supposed to convert normal pressure into skin friction; they, therefore, potentially are capable of reducing resistance within the limits indicated by the above figures. This always assumes, of course, that Zahm's coefficient is approximately representative of the true state of affairs. If it is not, then the substitution of a more accurate value will immediately show the corresponding limits of possible gain.

In any case these figures at least suggest the importance of eliminating normal pressure from aeroplane design, by the use of bodies of streamline form to enclose the larger masses on the machine.

This body resistance—in which is included the resistance of the struts, wires, and all framework except that actually forming the wings—is a resistance that is proportionate to the square of velocity (according to the above expression), and is a kind of extra dead load on the machine. It bears no relationship to the lift of the wings, and is, consequently, a detriment to efficiency. It is very important to discriminate thus between body resistance and the resistance of the wings.





4

STREAM LINE FORM

The resistance of an aeroplane wing in flight is itself of two kinds, one being the above-discussed skin friction of the surfaces, while the other is a dynamic resistance due to the creation of the aerial wave that supports the machine in flight.

This latter we may call the resistance due to load, and it will be shown that it is a function of the effective angle of the plane. If the effective angle is reduced, the resistance due to load *per unit of supporting area* will be decreased, but in order to support the same total load the area itself must be increased, which in turn increases the resistance due to skin friction.

Hence there is a relationship between the two kinds of resistance experienced by a wing in flight, which is why the wing needs to be considered separately, and why it is not proper to include the wing surface with the body surface

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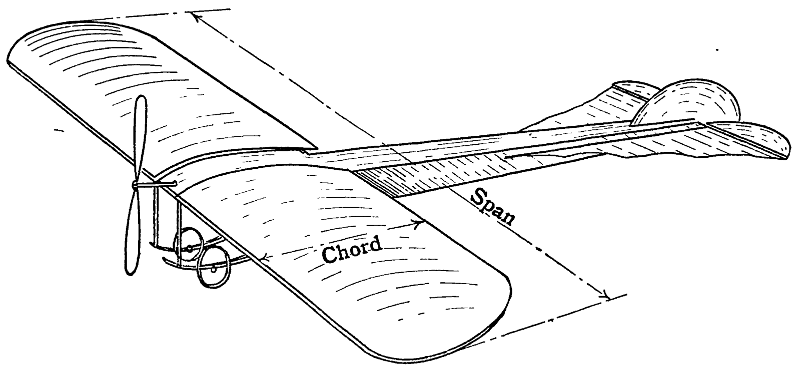
when calculating the skin friction resistance of the machine as a whole.

If Zahm's expression for skin friction is accepted, we may pass on to consider the resistance due to load. It is more convenient, as an intermediate step, first to find an expression for the lifting power itself.



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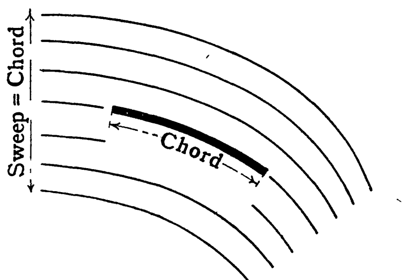
On the hypothesis that an aeroplane is supported in flight by the inertia of the air, it becomes possible to apply the fundamental equation $P = mf$ (where P = lifting force and m is the mass under acceleration f).

In order to apply this fundamental formula, it is necessary to find plausible expressions for the mass of air simultaneously disturbed by the wing in flight, and also an expression for the acceleration induced in that mass.

As to the mass itself, it is obviously limited in two dimensions by the span and chord of the wing (Fig. 5). Its third dimension, which corresponds to the depth of the stratum disturbed, is supposed to be a function of the chord (Fig. 6), and to have a coefficient in the order of unity. Whence we may write mass in the form ($\rho L l l = \rho A l$), (where ρ = density, A = wing area, L = span, and l = chord).



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Next comes the question of acceleration, which, from the very nature of the function of a wing, is determined by flight velocity and angle.

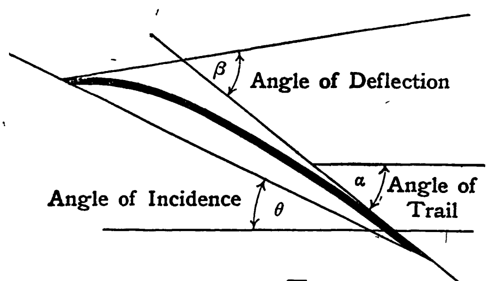
What is the effective angle of a wing?

Some say θ, the angle of incidence, some believe in the angle of trail α, but I submit that the angle of deflection β is the most plausible measurement (Fig. 7). It is immaterial, however, what angle is taken if the assumption be that the air stratum itself is deflected to the assumed degree.

Assuming that the angle of deflection as defined in Fig. 7 correctly represents the actual deflection of the air stratum, and that the camber of the wing is such as to produce uniform downward acceleration in each air molecule, then the final downward velocity with which a molecule leaves the trailing edge is represented by the expression ($V \tan \beta$) and the rate of acceleration itself by the expression

$$\left\{(V \tan \beta) \div \frac{l}{V}\right\} = (V^2 \tan \beta / l) \text{ (where V = feet per second).}$$

Thus, we have established plausible expressions for mass and acceleration, and their product should give a value for the lift or upward force of the wing in flight. Combining these expressions in multiplication, it will first be observed that the chord factor (l) cancels out of the expression, and since the area factor (A) may be removed by working in units of a square foot, or other convenient measure, we are left with



7

an expression in the order of (ρ $V^2 \tan \beta$). This, put into practical units for $\left(\frac{\rho}{g} = \frac{1}{400}\right)$ and (V = miles per hour), evolves the following definite formula for the lift of an aeroplane wing in flight
$$\frac{P}{\beta} = \frac{V^2 \tan \beta}{200}.$$

The graph of this expression is given in Fig. 8.

The next step is to find an expression for the resistance due to load, which involves the assumption that this resistance is confined to the apparent energy in the deflected air stratum. Energy is represented by the fundamental expression ($\frac{1}{2}mv^2$), and we have already evolved expressions for mass (m) and downward velocity (v).

Of these: $m = \frac{\rho}{g} Al = \frac{Al}{400}$,

and $v = V \tan \beta$,

whence $\frac{1}{2}mv^2 = \frac{V^2 \tan^2 \beta l}{800}$ foot lbs. per square foot of wing area.

Now this energy per square foot is dissipated $\left(\frac{V}{l}\right)$ times per second; hence the power expended on load may be expressed

$\frac{V^3 \tan^2 \beta l}{800 l}$ foot lbs. per second per square foot, which may be converted to resistance by dividing by (V); whence, resistance due to load is $\left(\frac{V^2 \tan^2 \beta}{400}\right)$ lbs. per square foot. (V is in miles per hour.)

The other part of the resistance to the flight of the wing is skin friction
$$R = \cdot000018 V^2,$$
whence the total resistance $= \left(\frac{V^2(\cdot000018 + \tan^2 \beta)}{400}\right)$.

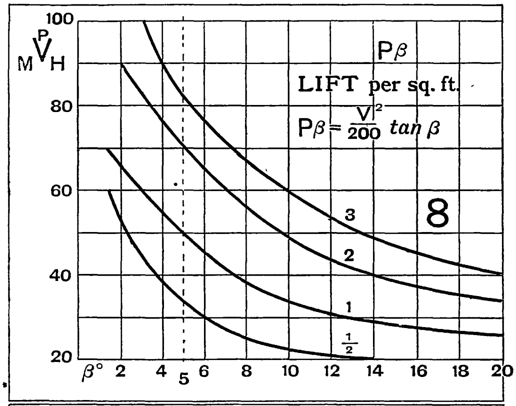
Having evolved expressions for lift and resistance, their ratio gives the coefficient of flight for the wings alone. Thus
$$V^2 \left(\frac{\tan^2 \beta}{400} + \cdot000018\right)\left(\frac{200}{V^2 \tan \beta}\right)$$
$$= \left(\frac{\tan^2 \beta + \cdot0072}{2 \tan \beta}\right).$$

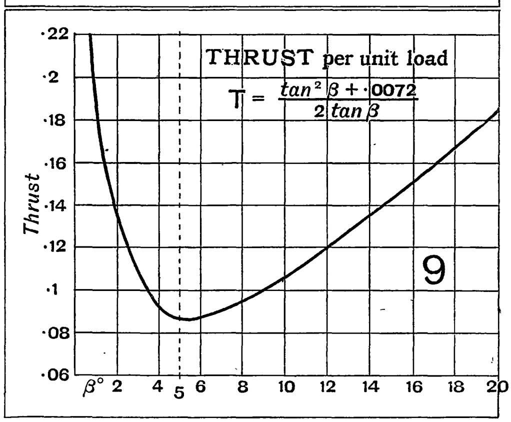
The graph of this expression is given in Fig. 9.

Now, what do these graphs show? That illustrating the coefficient of flight is particularly interesting, for it indicates that coefficient varies with the angle of the plane, is independent of velocity, and has a minimum value in the order of $\cdot085$ for an angle of deflection of 5°.

These numerical values result from the assumed coefficient for skin friction and the density of the air; the principle of an angle of least resistance to flight is unaffected by their variation. That the coefficient is independent of velocity is due to the absolute resistance and the absolute lift of a wing both being proportional to V^2. If the speed is doubled, the lift is quadrupled, and so is the resistance; their ratio is unchanged. It follows, therefore, that the most efficient variable speed machine is one having a variable area and not a variable angle. Also, that for a fixed area and weight there is a natural flight speed.

Since speed does not affect the coefficient, it follows that, from the point of view of the *wings alone*, the speed should be suited to the use of an angle of least resistance. In the graph, a very flat camber is indicated, which





implies a very high flight velocity to attain the loading that is common practice to-day. It is in respect to the very heavy loading (weight supported per unit area) of their wings that aeroplanes differ from birds, which have proportionately far larger wings.

In the construction of monoplane wings, larger areas imply greater spans and involve the use of more constructional material per unit of area in order to maintain the same strength. Thus, the net lift of the wing per unit of area diminishes in larger sizes, thereby involving

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proportionately higher speed for the same loading; whence there are good grounds for the general impression that a monoplane is naturally a fast type of machine. Equally, it explains the *raison d'être* of the biplane, which is the type for efficiency at slow flight speeds.

From the point of view of body resistance, a very high flight velocity is wasteful of power, but the magnitude of the loss depends on the efficacy of streamline bodies to reduce resistance. In practice, cambers representing far higher angles than that indicated as possessing least resistance are used, in order that machines of small area may rise at moderate speeds.

So, the significance of efficiency as a governing factor in long distance flights has been discussed, and a method of mathematical analysis has been suggested. This latter, I wish to say, is intended primarily as an elementary line of thought for students, analogous to presenting the problem of the steam-engine in the time-worn formula (PLAN/33000). It does not pretend to be either scientifically complete, nor is it based on practice. It is just a skeleton framework of theory intended to help those who have the concrete bricks of fact to make most use of them in building the houses of experience wherein a practical science can only abide.

DISCUSSION.

THE CHAIRMAN (Mr. Dugald Clerk), in opening the discussion said the audience had had the pleasure of listening with much interest to a most valuable paper. He was in hopes that the author would have stated whether it was probable that a flight would be made across the Atlantic at an early date, but Mr. Berriman had evidently remembered the fate of Dr. Lardner, who, in the early days of steam navigation, made a calculation as to the possibility of a steamship crossing the Atlantic, and came to the definite result that it could not. The author had not stated whether in his opinion a flying machine could cross the Atlantic, but from the various figures that had been given, he (the Chairman) gathered that at the present moment it looked rather hopeless. In dealing with the early history of aeronautics, the author very rightly mentioned Lilienthal and Pilcher, who were both killed, but there were several British investigators whose names he did not mention. For instance, there was Sir Hiram Maxim, who put a flying machine on rails and drove it with a light steam engine. The apparatus lifted itself from the rails, but Sir Hiram never obtained sufficient command of it to venture to fly in the air. Then there was Mr. Phillips, who made a great many experiments near London a good many years ago with an apparatus running round a sort of rail from a central post, the apparatus being driven by a steam engine and fitted with a screw propeller. It had a curious sort of wing arrangement, with a number of inclined slats not very much unlike the one the author had shown, and the apparatus was driven round the circle until it rose. A much more distinguished man, Sir Charles Parsons—who was presented with the Albert medal of the Society for his invention of the steam turbine—was very much interested in aeroplanes, and about fifteen years ago made a small steam aeroplane, alcohol being used for the fuel. The little machine, which was about five feet over the wings, did fly, but as no one was on board it very soon came in contact with the trees and fell. He had a photograph at home taken by Mr. Campbell Swinton showing the machine in the air. Previous to the investigations of Chanute and the brothers Wright in America, Professor Langley carried out a large number of experiments, his chief means of experiment being a steam aeroplane on rails upon a large barge floating in a lake. When the engine started, the aeroplane shot out from the top of the barge and flew over the lake, and Langley mentions an experiment in which the machine travelled for a mile or more. Langley died before his work bore fruit, but he determined a great many important facts; and a vast amount of the data on which modern aeroplanes were designed were tabulated for the first time by Professor Langley. One very interesting remark made by the author was that at present the engine must be kept going at its full power for the whole of the time the aeroplane was in the air. Langley made a series of very interesting experiments on the nature of the wind, for the purpose of ascertaining why it was that many birds were able to keep in the air for long periods of time without any flapping or motion of the wings. He came to the conclusion that it was due to the fact that the wind was not steady, but that it acted in successive impulses. It seemed a very curious idea that the bird could take energy from the fluid in which it was suspended, but that fact seemed to be undoubted. Some years ago Mr. Lanchester also made a most interesting experiment. He took a long piece of wood with three or four inclined steps in it, made a groove running along the steps and then put a handle at the end. If a ball was put on the lower plane, by manipulating the sliding part it was possible to cause the ball to rise up first one step and then another. That was quite possible, notwithstanding the fact that the ball was resting on the mechanism all the time, and illustrated the assertion that energy could be obtained from a fluid, although the object moved was entirely immersed in the fluid. He believed that the Wright brothers were now working upon that assumption, and the statement had recently been made that they had been able to stay in the air something like ten minutes, using the impulses of the air to keep them up. If that feature could be developed, and an aviator could depend, not on a steady breeze, but on a breeze with a series of impulses, it would be possible greatly to reduce the

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time when the full power of an aeroplane was required. He was very much interested in the use the author made of the word "efficiency," which arose, he presumed, from the constant use that was made of that term in engineering. People thought, as the author had said, of something with a 100 per cent. efficiency, and then reckoned how near they could get to that efficiency. Many years ago he (the Chairman) proposed the air standard of efficiency as a method of determining what were the possible efficiencies in internal-combustion engines such as petrol engines, and that air standard of efficiency, although it was well known that the air was not the working fluid, proved most useful; it gave something to measure by. In the same way the author was using the term as something to measure by, but it seemed to him that a struggle should be made to obtain some other method of expression in order that "efficiency" might be kept to its usual meaning. It seemed to him that if an aeroplane could be thought of more as a little platform projecting bullets downwards at a certain rate, some sort of standard of efficiency would be arrived at which would convey a clearer idea of what it was. One point that struck him very forcibly was the absolute necessity for high efficiencies in the petrol engine. There seemed to be a good deal of possible improvement in that direction. So far as he had tested petrol engines, he had never seen one that gave more than about 25 per cent. brake efficiency, *i.e.*, in which 25 per cent. of the heat of the petrol was converted into B.H.P. It was quite possible to design a petrol engine that would give 35 per cent. or even 40 per cent. efficiency, and in that way it was possible to obtain a great deal better figure than the ·65 pints of petrol per horse-power hour given by the author. It was a very remarkable result that petrol engines had already attained such a high efficiency, but there was much room for improvement. He had been very much interested to hear about the reaction of electric discharge, which was quite novel to him. It seemed to be a method of obtaining very high discharge velocities and possible reaction for lifting, but it was difficult to see where the energy was to come from. It might be that energy from the engines would be better used in that way, because a very large proportion of it was used in holding up the aeroplane.

Mr. Mervyn O'Gorman thought the essence of the paper was Fig. 8, where the author dealt with the angle β. But however much he would like to try to base practical work upon the angle β, he feared it was generally impossible to do so, because such a large number of results had been published in relation to aeroplanes, in which it was not possible, except from a minute diagram at the foot of the published results to know what the angle β might have been. He alluded to the book published by Eiffel, in which a number of diagrams were published, with a complete study of the data used by the author, but without any reference to the angle β which might exist between the tangent to the leading edge, and the tangent to the trailing edge. It might accordingly be said at the present time that, until much more experimentation had been done which gave more particulars of the curves, it was quite impossible to use experimentally and practically the considerations that the author had put forward. One of his assistants at the air-craft factory, Mr. Frederick Green, had taken great pains to interest himself in Eiffel's work, and had evolved a very pretty way of stating the basis upon which an aeroplane must be designed, founded upon experiments in which, unfortunately, the author's angles were not to be found. Had the original aerofoils used by Eiffel for his researches been worked out in the manner suggested a little time ago by himself, namely, by some equation being given for the curve, that difficulty would not have occurred. He was personally jeered at a little for working out an equation to a curve which was obtained simply by bending a piece of wood; but if one wished to put a record on paper, far the best way of fixing for all time an elaborate shape was to get an equation for it, so that anybody in the future could replot it and secure all the data of the curves. He hoped writers would, in future, give the equations to their curves, and when that was done he (Mr. O'Gorman) would very much like to take the author's angle β from the aerofoils and see what results could be obtained. With the Chairman, he was very much opposed to the author's use of the word "efficiency." "Excellence," or any other useful adjective which enabled one to realise that something nice was being obtained, was a better word. He thought it might be interesting to show in a very brief form how the results of Eiffel could be used in practice by means of Mr. Green's plan. (Mr. O'Gorman proceeded to describe, by means of several sketches on the blackboard, the plan evolved by Mr. Green for dealing with the question.)

Lieut.-Colonel R. de Villamil asked the author to describe how the centre of pressure in an aeroplane shifted, and for what reason.

Mr. A. R. Low thought that the curves which Mr. O'Gorman had described as due to the work of Green, bore a very strong resemblance to results obtained by Soreau, which were published in 1903, and were, therefore, prior in point of date to those of Green. With regard to the question on the movement of the centre of pressure, he agreed with Mr. O'Gorman that Eiffel's published results on the resistance of air and on the properties of various bodies constituted a source of wealth which it would take many years to exhaust. Eiffel established with the utmost clearness what had already been established with less assurance, that if a current of air was applied to a plane surface then, as the inclination was decreased, the centre of pressure originally in the middle of the plate shifted forward. That was a most important

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result from the point of view of the stability of the flat plane, because as the nose went down the force pushing it up shifted further forward and obviously tended to push it back into its proper position. On a curved surface, however, those results were altered in a most striking way. (Mr. Low illustrated his argument by means of several sketches.) Continuing, he said the Wright brothers were well aware of the natural tendency of a curved surface to instability, and balanced it by an extraordinary piece of "acrobatism" by putting a comparatively small elevator right out in front; and they must have been almost as skilful as acrobats to fly time after time in light winds without breaking their necks. On the other hand, the French designers built a tail far out behind the curved surface, which would more than account for any shift of pressure. Like the Chairman and Mr. O'Gorman, he disliked the use of the word "efficiency," and suggested that the French word "quality" of the surface should be adopted. The word efficiency was now used for the ratio of work put into a machine compared with the ratio of work taken out. He also wished to suggest that the division of resistance into normal pressure and skin pressure was not complete. (Mr. Low further illustrated his contention by means of sketches on the blackboard.) In conclusion, he said that it was very easy to plot curves, but Mr. O'Gorman would find it very difficult to reproduce them permanently in canvas and wood.

Mr. A. E. Berriman, in reply, said that the various speakers had endeavonred to put a practical aspect on the paper, which was exactly the object he had in view in writing it. In reply to the criticisms which had been advanced against the use of the word "efficiency," it would be remembered that personally he had said that he preferred to use the term "co-efficient of flight." Mr. O'Gorman had shown a curve for the horse-power required. The fact that wing quality was independent of speed meant that the horse-power required to propel the wings through the air was purely a function of speed. A straight line could, therefore, be drawn representing the horse-power required; but when the body resistance was taken into consideration a V^2 law applied. There was a certain value which represented a fairly efficient angle, but on either side there was a considerable inefficiency. (Mr. Berriman proceeded to illustrate his remarks by means of sketches dealing with this particular point and also the question of normal pressure and the question of travel of centre of pressure.) As far as he understood it, the reason for the change in travel of the centre of pressure was due to the wind getting hold of the top of the downturned front edge of the wing. There was in the first instance a slightly upward trend in the wind, which was the reason that wings flew with a downturned front edge, *i.e.*, when in horizontal attitude. He regretted that he had not referred to Langley's work. Langley's work on aeroplanes was on the point of being successful, and to his mind it could have been made successful within a few months of the time that the Wrights achieved their first famous flight. It was sometimes thought that Langley's work was very much earlier than that of the Wright brothers. It was so in some respects, but the final failure took place only a few months before the Wright brothers made their first mechanical flight. Had Langley been successful, his name would have gone down to posterity with the same prominence as that of the Wright brothers. Some of Langley's work on skin friction was exceedingly interesting. He was one of the people who did not believe in skin friction at all; in other words, he would have said, as far as he (the author) understood his work, that that particular factor should be left out altogether. As far as he could understand, Langley made his experiments on a whirling table, and he used little flat planes which he described as thin sheets of wood in aluminium frames. Personally he had the impression that those planes were uncommonly heavy for experimental work. That particular line of thought indicated that when a very heavy loading existed it was necessary to fly extraordinarily fast for the angle to become flat enough to reach maximum efficiency. Langley mounted his planes on a whirling table and made them go faster and faster, and found that the skin friction on the planes was negligible compared with the resistance to load. Had Langley been able to run his machine fast enough he would ultimately, according to theory, have arrived at a point where the skin friction and the resistance of load would be equal to one another; and if he had pushed the speed further and further he would have found that the skin friction would have increased in actual magnitude beyond the resistance load; and he would not have said, as he did say, that the skin friction was a negligible quantity as a law. Practically what Langley said was, that the faster one flew the less power was required, which would have made flying to America a matter of comparative simplicity.

On the motion of the Chairman a hearty vote of thanks was accorded to Mr. Berriman for his interesting paper, and the meeting terminated.

FLORENCE AND ITALIAN DEVELOPMENT.

Some interesting facts regarding economic progress in Italy are recorded in Major Percy Chapman's report for 1910 on the trade and commerce of Florence and the large consular district appertaining to it. From this it appears that one of the chief obstacles to freer interchange of goods throughout the kingdom of Italy is the deficiency of double railway lines, and the consequent accumulation of goods in the different stations and depôts. As, however, under existing budget arrangements the railway authorities are only allowed to spend £600,000 per annum for that purpose, it will be quite twenty years before such

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double tracks as are required urgently at the present time are laid down.

A gratifying increase in the savings of the nation is observable. In 1900 the savings amounted to £80,000,000, and in 1909 they had risen to £200,000,000. Wages in Italy also commenced to rise in 1900 and have continued to do so since, a fact which doubtless accounts to a great extent for the very large increase in the deposits. Considered with reference to population, Lombardy comes first with £7 14*s.* 5*d.* savings per head, Emilia next with £4 10*s.*, Latium third with £4 7*s.* 2*d.*, and Tuscany fourth with £4 4*s.*

In regard to woods and forests, a Bill has been laid before the Italian Parliament by which the only forestry school in Italy, which since 1869 has occupied the old convent of Vallombrosa, will be transferred to Florence and turned into a university for the science of forestry. In summer practical courses will be held in the State forests of Vallombrosa, Comaldoli, Abetone and Fodonica. The institute raised to the dignity of a university would hardly prosper at Vallombrosa, which is situated at a height of 1,000 metres above sea level, isolated from every kind of intellectual surroundings, while in Florence it will have the advantage of being in the immediate vicinity of public libraries, museums, and scientific equipment for study and research. The institute when transformed will issue degrees of Doctor in Forestry Sciences.

THE EGYPTIAN COTTON CROP.

Since the publication of an article on Egyptian cotton in this *Journal* on October 14th, 1910, some more experience has been gained by those who devote their attention to the culture of the most important crop in the country of the Nile. Attention was then drawn to the gradual deterioration of the cotton crop, which for long has held the highest place in the cotton market for quality, if not for quantity. The chief causes of the falling off of the Egyptian crop have been stated by experts to be (1) over-irrigation; (2) exhaustion of the land; (3) insufficiency of new, good seed; and (4) the gradual admixture of the crop with "Hindi" cotton, this being the name of an undesirable type of cotton with a short, weak fibre that injures the high grade of Egyptian varieties by infesting them with hybrids.

In August, 1910, a Department of Agriculture was formed at Cairo, with a suitable staff, to study and deal with questions that have up till now been referred to the Khedivial Agricultural Society. The Egyptian cotton crop of 1909–10 was very poor in quantity, and owing to the smallness of the supply prices were exorbitantly high. The market was already threatened by American enterprise, for the manufacturers of the States knew how to produce an imitation of the goods made with Egyptian cotton, which, if not so satisfactory, answered many purposes. The Egyptian crop of 1910–11 was so surprisingly good, and reached so high a figure, that harvest thanksgivings were held in Cairo churches, and the experts who continued to utter warnings were altogether in the minority.

The new Department of Agriculture had signified to the farmers and peasant cultivators that it was quite ready to offer advice with regard to selection of seed or cultivation, but the good crop of last summer gave such a feeling of security that the fellah appears to have taken even less care than usual. In the month of June a severe attack of cotton-worm, a much-dreaded insect pest, made its appearance. The Agricultural Department organised a special system of inspection, that was continued throughout the summer. Although all available means were adopted, the scourge raged throughout the summer. The only practical remedy was to kill the coming generation—not so much the already matured worm, but rather the small house that the pupa forms for itself, composed of earth and lime, and lined with a kind of silk. This is very hard, and needs breaking up in order to get at the pupa within and drown it. The loss by cotton worm this year is estimated at £5,000,000.

Simultaneously with the cotton-worm plague came the news that the United States Department of Agriculture has been developing the culture of Egyptian cotton in the United States. The only good results on a considerable scale have been obtained in the Colorado River region, where the climate and other conditions are similar to those in the Nile Valley, and are suited to the long staple Egyptian cotton. Six hundred thousand acres of good land will soon be growing Egyptian cotton in the Imperial, Yuma, Salt, and Gila Valleys. A fifth of this acreage could produce the amount of Egyptian cotton imported each year for the use of New England mills.

An invention has been perfected for the prevention of cotton-worm, a kiosk in the shape of a trap. A demonstration was given in June in a field near the Gaffaria Canal, in the presence of a number of well-known persons. The door was closed and sealed. When officially opened in the morning it was found that more than a thousand moths had been captured during the night. Numbers of eggs were also found in the kiosk, such as are laid by the cotton worm upon the leaves of the plant. Something may certainly be hoped from the invention; at the same time it will be some time before it can be placed on the market.

To regulate the use of cotton-seed, a matter in which Egyptian farmers have been very careless, the Agricultural Department issues circulars to the heads of villages and government cashiers in the provinces, detailing the manner in which carefully-selected cotton-seed will be put on sale at the markets of the Egyptian Markets Company, and the facilities to be accorded to farmers in the payment of the price of such seed. The seed is delivered in sealed sacks.

The most hopeful point in the outlook of the Egyptian cotton market is that since the arrival of Lord Kitchener at the British Agency the long-discussed plan of draining the Delta is being put

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in hand. By this means the subsoil water, resulting from the irrigation, will be drained off. The enormous cost of the undertaking has prevented the Government from taking up the matter before.

A well-known Egyptian, writing to one of the native papers in Cairo last August, suggested as a remedy for the deterioration of the crop, that the whole country should be restrained from planting cotton for a year. He points out that, although the remedy is heroic, the price of cotton would rise during the years following, owing to the great yield of the crop on one hand and its superior quality on the other.

The crop of 1911–12 is likely to be unfortunate. The temperature nearly all through the summer has been rather below the normal, which was not favourable, the crop being liable to have its growth checked under these circumstances. In Upper Egypt the crop suffered from fogs and blight, and from attacks of boll-worm. As the cotton-worm appeared early it attacked chiefly the early bolls which usually give the best cotton, so that both in quality and quantity this season's crop is likely to be inferior to last year's.

In spite of the shortness of the supply, prices are lower than they have ever been. Mr. James I. Craig, M.A., F.R.S.E., Director of the Computation Office of the Survey Department, has lately published some cotton statistics. His general conclusion is that "The causes of the decrease in yield have been largely beyond the control of human agency, but this does not mean that they will be beyond human control in the future." Some of his conclusions are as follows:—"The rate of decrease is less in Upper Egypt than in Lower Egypt, but still the decrease exists there also. Part of the decrease in the general average yield for all Egypt may be accounted for by the lower average fertility of Upper Egypt; extension of cotton cultivation to poorer land in Lower Egypt may account for some of the decrease, but scarcely for all. None of these causes, however, will account for the fluctuations about the fairly steady rate of decrease. Change of rotation from one of three years to one of two years may account for some of the decrease, but scarcely for all . . . The cultivation of cotton is probably less intensive now than fifteen years ago . . . The value of the crop per head of the agricultural population has nearly doubled in fifteen years."

YIELD OF THE SUGAR-BEET IN EUROPE.

The statistics given below, based on the average production of sugar during the last five years in ten of the principal beet-growing countries of Europe, give:—

1. The yield of raw sugar per hectare and English acre of beet grown.
2. The percentage of raw sugar obtained from the crop.
3. The weight of the crop per hectare and English acre.

Germany heads the list as regards the production of sugar at the rate of 4,895 kilogrammes for each hectare (39 cwts. per acre), or nearly double that of Russia, which produced only 2,440 kilogrammes per hectare (19·4 cwts. per acre). Italy gave the best results as regards the quantity of beet grown, being at the rate of 30,340 kilogrammes per hectare (12 tons 2 cwts. per acre). On the other hand, the yield of sugar was one of the lowest. It is greatly to be regretted that Great Britain does not head, or at all events figure, in this list. Is this due to ignorance or apathy on the part of inhabitants of these islands?

Country.	Yield of Raw Sugar.		Percentage Sugar Obtained.	Weight of Crop.		
	Per Hectare. Kilogrammes.	Per Acre. Cwts.		Per Hectare. Kilogrammes.	Per Acre. Tons.	Cwts.
1. Germany	4,895	39·0	16·32	30,000	11	19
2. Sweden	4,347	34·6	14·95	29,070	11	10
3. Belgium	4,232	33·7	14·90	28,980	11	10
4. Denmark	4,191	33·3	13·97	29,990	11	19
5. Austria-Hungary . .	4,062	32·3	15·84	25,630	10	4
6. Holland	3,931	31·3	14·96	26,270	10	9
7. Italy	3,682	29·4	12·13	30,340	12	2
8. France	3,507	28·0	13·18	26,600	10	12
9. Spain	3,494	27·9	12·34	28,310	11	6
10. Russia	2,440	19·4	15·57	15,670	6	5

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THE COST OF LIVING.

In a paper on "The Course of Prices at Home and Abroad, 1890–1910," recently read before the Royal Statistical Society, Mr. R. H. Hooker, in comparing prices in 1910 with those of the decade 1890–99, showed that wholesale prices had risen in this country by about 15 per cent., in Germany and the United States by about 30 per cent., and by intermediate amounts in France and Canada. Wholesale food prices in 1910 had risen by only about 6 or 8 per cent. here, and scarcely at all in France, while a rise of between 20 and 30 per cent. was shown in the other countries. The raw materials of industry had risen much more, viz., by 25 to 40 per cent. in all countries. A great contrast was shown between this country and America, where food and materials had risen by practically the same amount; while here, food-stuffs had risen very much less, although they had attracted much more public attention.

The data as to retail prices were scanty, and not very reliable. It appeared that, on the whole, since 1895 they had risen by about as much as wholesale prices, though in the United States they seemed to have lagged behind. Comparisons of the course of prices with wages, for which a few data were available for this country, France, and the United States, indicated that wages had not fallen behind prices except in the last year or two. The curve of wages was, however, always the smoother; and if it did not rise so abruptly during times of high prices, like the present, on the other hand it fell very little during times of low prices. In France, in particular, wages appeared to have risen most, relatively to prices, but the data were very far from conclusive.

Considering the causes of the present high level of prices, Mr. Hooker pointed out that they were threefold. First he showed how the increased production of gold in the early fifties had resulted in a rise of prices in the following quarter of a century, and how a diminished gold production had been accompanied by a steady fall in prices during 1875–95; and then pointed out that the enormous output of gold since then was sufficient to cause a rise of some 10 per cent. in the stocks available for currency. Secondly, he considered that we were now near the crest of one of those waves, due to increased demand for materials, especially minerals, which periodically recurred in prices, and which were generally associated with industrial prosperity. Thirdly, the price of food had risen very greatly during the past three months owing to the droughty summer in north-western Europe. The two former influences, superimposed, had resulted in very high cost of materials. The two latter were temporary, and when they had passed away prices would again be lower. But the effect of the large output of gold would probably persist for some time, and prices might be expected to oscillate around an average that was not likely to decrease at present.

The relatively great advance of food prices in the United States was due to the inability of agriculture to keep pace with the expansion of population; in England, on the other hand, the diminished supplies from the United States had been fully covered by supplies drawn from other countries, notably Argentina: hence the rise in food prices was relatively small here. Changes in tariffs were responsible for some of the differences noted between prices here and abroad.

THE SIAMESE TOBACCO INDUSTRY.

In Siam tobacco is produced most extensively in the Provinces of Petchaboon and Rajburi. The former is an inland province north of Bangkok, the latter has its easterly coast on the Gulf of Siam. In the first-named province the chief tobacco region is Petchaboon town. The leaf grown there is generally regarded as superior to that produced anywhere else in Siam. In Rajburi Province tobacco is cultivated mostly in the district of Wang Khanai, in Muang Kanburi. The tobacco of Siam is of two qualities, strong and mild. The strong quality is used both for smoking and chewing; cigarettes are made of it with lotus, banana, or betel-tree leaves as wrappers. The mild quality, manufactured usually as fine cut, is used solely for chewing with the quid of betel leaf and areca nut. The chief markets are in Bangkok, whither the tobacco is brought from the interior by boat and sold from the moorings in front of the monasteries Wat Kalya and Wat Bophit Bhimuk. Much of the tobacco is sent inland to the provinces of Korat, Chantaboon, Ayuthia, Nakon Sawan, and others. The customs reports show that certain quantities of Siamese tobacco were shipped to Cochin China and to Hong-Kong during 1910. Some is occasionally sent to Singapore and the Malay Peninsula. Most of it is consumed locally. The soils usually selected as suitable for tobacco cultivation are of three kinds, namely, bamboo forest, scrub land, and high grass land. The American Consul-General at Bangkok says that the soil that is considered the best is sandy or black and yellowish loam. In this kind of soil in Petchaboon Province tobacco can be grown on the same area successively for twenty years without the need of fertilisers, while in Rajburi it can be grown successively only for three years at the most. Nursery grounds have to be dug to about nine inches in depth and well broken, and then prepared into raised beds three feet wide. The seeds are sown broadcast on the beds, where some protection against the sun must also be provided. Transplanting takes place when the shoots are nine inches high. The actual season for transplanting differs according to the level of the land. If high it takes place about November, if low in December, and in very low-lying ground as late as January or February. The reason for this difference of the season for transplanting is the simple one that high grounds get rid of moisture the sooner. In March or April the crops are

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harvested. The time chosen depends upon the colour of the leaves and the picking is upward from the lowest ones. Two or three top leaves from each plant are set aside for manufacture into a special high-class quality. If a uniform grade is required the whole plant may be shorn of its leaves indiscriminately at the same time. For maturing the gathered leaves are first ribbed and then placed on the top of each other, rolled up and put away for two days, after which they are unrolled and packed on the top of each other to a thickness of about six feet. Round pieces of wood are pressed on the top of the leaves, which are rolled into the shape of cylinders; the wooden rollers are then taken out and the leaves left to dry in the shade for about three days. They are then finely cut, well separated from impurities on large sieves, and dried in the sun for one day. If a strong quality and dark colour are desired, the sun drying may be extended to two days. At night the cut tobacco becomes soft enough for manipulation into different shapes for packing and shipment. The packing is either in bales made of large dried leaves, called "baitong ruong," or in bamboo crates.

HOME INDUSTRIES.

The Poultry and Tobacco Industries.—The Development Commissioners have been taking evidence on tobacco cultivation in Ireland and poultry development in Great Britain, and an application is about to be made to the Development Fund to establish and maintain a poultry institute in a convenient centre in England. The main object of the institute would be to investigate and demonstrate the best methods of breeding, rearing, and keeping all kinds of poultry with a view to the increased production of eggs and table poultry in this country, and the preparation and marketing of such produce. We are much behind Continental nations in agricultural education. In Belgium, for example, all primary schools in country districts give instruction in agriculture, and in some cases this is followed up by continuation classes held in the evening, and attended by children who have recently left primary schools, and are probably already engaged in country pursuits during the day. Then there are the travelling schools, where agriculture, dairying and domestic economy are taught. But the most important part of the agricultural teaching given in Belgium is directly organised by the State experts (*agronomes de l'État*), of whom there are twenty-seven with eight assistants. These *agronomes* have organised a large number of popular lectures on general farming, the feeding and management of cattle, farriery, fruit growing, market gardening, floriculture, etc. Many interesting particulars of the way in which the Belgian State authorities seek to advise and guide cultivators are given by Mr. Rowntree in his "Land and Labour Lessons from Belgium," and he says that it is instructive to accompany one of the *agronomes* to market and see how constantly he is hailed and consulted on all kinds of questions. Much service is also rendered by the experimental plots, of which there are about a hundred in Belgium under the charge of the *agronomes*. The Belgian cultivator may be more willing than the British farmer, or small holder, to accept advice and guidance from experts, but the Government might usefully do much more than it does—until very recently it did nothing—towards solving the problem of how best to further agricultural education. The enlightened policy of Belgian statesmen in this direction has had very remarkable results. Mr. Rowntree gives figures which show that, comparing the net imports, Belgium imports live stock and meat to the amount of 1*s.* 8½*d.* per head of the population per annum, against 23*s.* for the United Kingdom. She imports dairy produce (butter and cheese) to the value of 2*s.* 3*d.* per head, as compared with 12*s.* 9*d.* for the United Kingdom, and eggs to the value of 7*d.* per annum against 3*s.* for the United Kingdom. Of fruit, the United Kingdom's imports amount to 2*s.* 6*d.* per head, whereas Belgium exports fruit to the value of 1*s.* 4½*d.* per head. An equally wide difference is to be found in the case of vegetables, the United Kingdom importing 2*s.* 1*d.* worth per head, whereas Belgium exports 8*d.* worth per head. The prices of food stuffs in the two countries are very similar, nor can the differences be accounted for by the *per capita* consumption of the various articles, for though the Belgian eats less meat than the Briton he consumes more vegetables and more grain. Nor can protective tariffs solve the problem, since the difference between the two countries is as striking in the case of eggs and vegetables, which are unprotected, as of meat and dairy produce, which are protected. In Belgium the value of food imported amounts to an average of £1 18*s.* 2*d.* per head of the population per annum. In the United Kingdom the corresponding figure is £3 14*s.* 10*d.*, notwithstanding the fact that Belgium has a population of 589 persons per square mile and the United Kingdom only 342. In face of these facts and figures it is very difficult to controvert Mr. Rowntree's conclusion that agriculture in England might and should become much more intensive. The soil of Belgium, taking it as a whole, is less good than that of Britain, and the climate is no better. She does so much better partly owing to the light-railway system, and her methods of agricultural co-operation, but also, and largely, because, thanks to the efforts of the State, her farmers know how to get all that is to be got out of the soil.

The Electrification of Railways.—The electrification of railways grows apace. First came the tube railways, then the Underground, followed by the North-Eastern, and the system installed by the Brighton Company. And now the announcement is made by the London and North-Western that several important improvements are about to be carried out to enable it to enter into more effective

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competition with the railways which deal with London's suburban traffic. We are almost within sight of the time when the whole of the suburban traffic on our railways will be electrically driven. If the railways are to fight the tramways and motor-cars successfully, they must do so with their own power. With the growth of manufacturing centres, and the driving further afield of desirable residential localities, rapidity of transit becomes indispensable, and the system of traction which gives a high schedule speed where stops are frequent is the one that will succeed. Assuming the maximum economical schedule speed with stations about one and a quarter miles apart to be thirty miles, and one hour as representing the maximum distance the business man is willing to live from his work, the radius of economic and remunerative suburban traffic is, approximately, thirty miles from any large town. In a paper on the electrification of railways recently read by the manager of the Lancashire and Yorkshire Railway Works at Horwich, it is said that an electric motor-car would run fifty thousand miles without visiting the shed other than for stabling, and could be kept in continuous service for twenty hours daily, the only attention required being brake adjustment. A steam locomotive on a similar service must obtain coal every hundred and fifty miles, and requires a thorough washing out and overhaul every twelve hundred miles at the least. By reason of its higher acceleration and average speed on short runs, the electric service could be increased in frequency with the same headway between trains, thus increasing the capacity of the line. Of course, the nature of a railway's mileage must have an immense influence on the choice of a system of electrification, and the single-phase system suitable for one line may not be applicable to another. And whilst the financial difficulties to be reckoned with in the electrification of suburban lines are great, it would be a stupendous task to insure a profitable return upon the capital required to electrify one of the great systems. Thus Mr. O'Brien estimates that the cost of electrifying the whole Lancashire and Yorkshire Railway system would be £5,700,000 in round figures, and to pay 4 per cent. interest on this would take £228,000 per annum, which means that if the cost of operation remained the same, and the receipts were not increased, the dividend would fall by nearly $1\frac{1}{4}$ per cent. For although certain economies might be reckoned on, certain expenses would increase; so that it would be necessary, as the result of electrification, to make certain of an immediate increase of about 5 per cent., say, £300,000, in total receipts, an increase that would have to come mainly from the suburban areas.

Fining in the Weaving Trade.—It is inevitable that a system of fining should tend to bad relations between those who exact the fines and those who have to pay them. The fining of weavers in the cotton trade has had this effect, and there are indications that it is likely to be discontinued, or at least greatly lessened, in the near future. According to a correspondent of the *Cotton Factory Times*, in one weaving centre "two or three employers have posted notices to the effect that all fines deducted from the weavers' earnings will in future be distributed equally between all the weavers employed at these mills." But this solution of the problem is not likely to commend itself to many of the opponents of fining. It does, indeed, meet the objection that employers are able to make a profit out of fines, but even weavers who have gone through the year without a fine may be disinclined to participate in any yearly distribution. The *Factory Times* says that "these Lancashire employers are giving up fining at the request of their weavers, and intend tentatively to see what the result will be at the end of six months." The abolition of fines might make the bad or middling weaver's job less secure than before, but it would make for efficiency.

The Minimum Wage for Co-operators.—Resolutions in favour of the principle of the minimum wage for all females in their employment have been passed by three successive Co-operative Congresses. These resolutions have now been followed by a report issued by the Directors of the Co-operative Wholesale Society which will be considered by delegates from Co-operative Societies all over the country at their meeting next month. The report is hostile to the proposal, chiefly on the ground of cost. The minimum scale proposed starts at 5*s*. per week at the age of fourteen, and increases to 17*s*. per week at the age of twenty. This would increase the present wage bill by £60,000 per annum. The report states that the Co-operative Wholesale Society employs 7,072 females, 5,407 of whom work forty-eight hours or less per week. Wherever the women are in a trade union the standard rate of wages demanded is paid, and where they are not the wages paid are always the highest in the district. The directors would welcome the formation of a Trade Board, under the 1909 Act, and would be pleased if its principles of a minimum wage and a maximum working day could be enforced on all employers; but, as matters are, the adoption of the minimum wage for all females would lead to employers demanding from employees corresponding standards of efficiency, and girls over a certain age would not be employed without previous experience.

Indigo Dyeing.—A special committee is about to be formed in connection with the Textile Institute to consider the question of fixing a recognised standard of indigo-blue dyes in cloth. There is an increasing quantity of goods which contain but a very small percentage of indigo-blue, and it is thought that if a standard could be established it would encourage honest trading. The Admiralty, the War Office, and the Post Office are all large purchasers of goods containing the

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dyes in question, and they are much interested in the proposed inquiry. It is understood that both the Admiralty and the Board of Trade have asked to be represented on the committee.

CORRESPONDENCE.

BANKING IN THE UNITED STATES OF AMERICA.

Mr. James Douglas, in his interesting address to the Society on the 22nd November, made mention of the unpremeditated effect of the Sherman Act upon railway ownership, and showed how the prohibition contained in the Act against "combinations for restraint of trade" had, in fact, stimulated speculative enterprise in the form of combination by purchase. His further explanation (which is not included in the printed report) was that the restriction sought for by the framers of the Sherman Act was to prevent monopolies of all kinds. Under it no firm or company can make any sort of arrangements for joint running or for limit of prices, or do other such things for mutual benefit, and naturally the more ardent spirits, who have looked beyond the length of their own shadows, have soon found a wider field without for many years being overtaken by the law.

I do not remember having heard this view of the relation of the trusts and the Sherman Act expressed before, nor have I noticed any suggestions to the same effect in any recent financial papers. Now, however, that I fully appreciate the view set forth by Mr. Douglas, and amply demonstrated by circumstance, it comes upon me that another effect has been produced in another direction, which also could not have been foreshadowed in the minds of the framers of the Sherman Act.

It is evident from what Mr. Douglas said that the law as to co-operation by mutual consent has been closely guarded and respected, and apparently by none more than by the banks.

It is equally evident that the banking system, unlike most other industries in the United States, is less progressive than the systems of nearly all other civilised countries, and is, in fact, as out-of-date as an old sail windmill.

I think it may be argued that these conditions are as much the offspring of the Sherman Act as are the trusts, and the conclusion can only be that that Act was framed with more regard for sentiment than as a workable law. The banks are too much in the public eye to evade the written law, and they are now at their wits' end to see how they can keep it and break it at the same time. That is, they wish, and indeed are being forced, to co-operate for the ordinary regulation of finance, and to do so they must get a special Act passed to enable them to evade the law. But to keep true to sentiment, they propose to remain isolated units among the massed forces of industry, politics and speculation all around them, and at the same time jointly to own and manage a central institution which is to be their regulator and guide.

All this seems very inconsistent and contradictory. I should like to know whether these results are, as I suggest, traceable to the Sherman Act, and also, whether that Act prohibits, directly or indirectly, the opening of branch offices by banks in neighbouring towns, other States, and in foreign countries, and the discounting of bills drawn against goods passing from one State to another, or to a foreign country? We read occasionally of the merger of two banks in the United States. As this presumbably cannot mean an amalgamation such as we have in England, does it mean that one of the banks is wiped out without any increase of banking facilities to the public?

My reason for asking these questions—which I do with diffidence, and in no spirit of adverse criticism—is because I find it difficult to get them answered in London, and until they are answered it is impossible for Englishmen to appreciate the admitted defects in the banking system of the United States.

REGINALD MURRAY.

Dr. James Douglas, to whom the foregoing letter has been submitted, writes as follows:—

I regret that I am not sufficiently conversant with the banking laws of the United States to answer Mr. Murray's questions. I am, however, sure that the Sherman Act has had little influence on the action of the banks in their transaction of strictly banking business. The incorporation of banks has been under State laws, and no State can authorise a bank to erect branches in another State: hence the concentration of capital at the great financial centres instead of its diffusion. As in Canada, under its banking laws a State bank may become a National bank, and thus secure the right of issuing notes, which are guaranteed by the Federal Government by submitting to rigid Federal inspection and other conditions, but it does not thereby secure the right to organise branches outside the State. The effect has been virtually to stop the issuing of banknotes by State institutions. These notes used to be current generally only in the State where issued, and were often refused, except in the neighbourhood where the managers of the banks were well known.

I believe, however, that there is a very widespread desire that Congress should pass a Federal Banking Act, which would remedy the defects of the present banking system and remove its limitations.

NOTES ON BOOKS.

FARM WEEDS OF CANADA. By George H. Clark, B.S.A., and Andrew Fletcher, LL.D., F.L.S., with Illustrations by Norman Criddle. Second edition. Revised and enlarged by George H.

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Clark. Dominion of Canada, Department of Agriculture, Branch of the Seed Commissioner. Published by direction of the Hon. Sydney A. Fisher, Minister of Agriculture, Ottawa, 1909. For sale in single copies only. Government Printing Office Bureau, Ottawa. Price, $1 [5*s*.].

It is impossible to take up for review this model "Blue Book," as we should call it here, without being predisposed in its favour by the patriotic enthusiasm enkindled in this country on the vital question of the future of the British races in America by the speeches of Earl Grey on his recent return, as the retired Viceroy, from Canada, and the speech, the most inspiring on its direct subject known to me, by Sir Henry Mortimer Durand, our late Ambassador at Washington, from the Chair of the Royal Society of Arts, on the 22nd ult., at the lecture by the learned Dr. James Douglas on "The Industrial Progress of the United States." But the volume needs no such adventitious and fortuitous aids to force a reader's favour and reinforce his confidence. It commends itself all-sufficingly at a glance, and in its entirety, and in every detail. It is not issued in a flimsy paper wrapper, and weakly stitched together, as is an English "Blue Book," but in a crimson leather binding, lined with watered crimson silk, and with the sheets and binding so strongly "forwarded" that it is ready forthwith for its abiding place on the library shelf. It is beautifully printed throughout in large type; and the coloured illustrations are at once most truthful portraits and charming pictures. They are drawn with such precision, and force, and in such correct perspective, that looked at with half-closed eye-lids, they stand out in the fullest stereoscopic relief, and the actuality of the living plants themselves, "all a-growing, all a-blowing": and they are all such healthy, fresh, and creditable specimens of their species! As for the text, in its scientific botany, its agricultural botany, and its popular and literary botany, it is in every way admirable, and an exemplar for even the Governments of America, and India, and Germany, in all such official publications. In a word, the volume in its contents plays up to the titlepage, and the titlepage is found an absolute warranty of the worth of its contents; and that is why I have copied it out and paraded it at full length at the head of this Note.

The book is full of multifarious features of interest; but I will only refer to the few that most interest myself. Of the 76 full-page coloured illustrations, 71 are of plants, and five of 100 magnified samples of seeds; while of the 71 illustrations of plants, eight are of endogenous species, grasses, sedges, and the like, and 63 of exogenous species, or bright flowering herbaceous field plants; and of these, 40 are common to England and Canada, and only 23 indigenous to Canada—or, at least, plants naturalised in Canada from other countries than Great Britain and Ireland. These 23 are:—*Amaranthus retroflexus*, Chinaman's grass; *Ambrosia trifida*, Crown weed, King weed; *A. Artemisifolia*, Roman Wormwood; *Aryxis Amarantoides*, Russian Pigweed; *Brassica orientalis*, Rabbit-Ear, Klinkweed; *Circium arbense*, Soft Field Thistle; *Draba nemorosa*, Yellow Whitlow grass; *Hieracium praealtum*, King Devil, Gochnat; *Iva axillaris*, "Poverty Weed"; *Lactuca pulchella*, Blue Lettuce; *Lappula echinata*, Blue-bur, Sheep-bur; *Lepidium apetalum*, Pepper-grass; *Œnothera pallida*, "Evening Primrose; *Neslia paniculata*, Ball Mustard; *Potentilla monspelensis*, Rough Cinquefoil; *Rumex crispus*, Yellow Dock; *Rudbeckia hirta*, "Black-Eyed Susan"; *Silene noctiflora*, Night-flowering Catchfly; *Sisymbrium altissimum*, Tumble Mustard; *S. incisum*, Tansy Mustard; *Solidago graminifolia*, "Golden Rod"; *Spiraea tomentosa*, Steeple-Bush, and *Vicia angustifolia*, Wild-Tare, Wild-Vetch, and Wild-Pea.

Among the remaining 40 illustrated plants, common to England and Canada, there is no note of either the "Red Poppy," the "Blue Bottle" [*Centaurea Cyanus*], or the "Common Camomile," the commonest of the loveliest weeds in English cornfields. *Erigeron Canadensis*, is, on the other hand, the only Canadian field plant that has become apparently naturalised in Great Britain.

Another remarkable thing about these Anglo-Canadian plants is the haphazard way in which their English names have been attached to them. Thus, in the foregoing list, "Golden Rod" is the name attached in England to *Solidago Vergaurea*, also called "Aaron's Rod" by us, and to *Verbascum Thapsus;* "Black-eyed Susan" to an Anglo-Indian garden plant, the once familiar scientific name of which I am no longer able to recall; "Evening Primrose" to *Œnothera biennis;* and "Poverty-weed" to *Melampyrum arvense*, and *Chrysanthemum leucanthemum.* All this is very puzzling, and reaches its climax in the case of *Erigeron Canadensis*, called by the Canadians by the names of "Fleabane," the name in England of *E. acre;* and "Butter-weed," the name in England of *Pinguicula vulgaris;* and "Fireweed," our *Plantago media;* and "Mare's-tail," our *Hippuris vulgaris;* and "Blood Staunch," a corruption of "Blood Strange," i.e., "constringe," our name of *Mimulus minimus;* and "Bitter Weed," our name for various species of *Populus.*

Another point of interest in this connection is the disappearance from Canada of almost all the English sacred names of plants, whether these plants have been imported from England, or are indigenous to Canada; of such names, for instance, as "God's Eye," "Aaron's Beard," "Angel Eyes," "Jacob's Ladder," "Noah's Ark," "Herb Grace," "Star of Bethlehem," "Virgin's Bower," "Our Lady's Pincushion," etc., "Mary's Thistle," etc., "Herb Christopher," etc., to about a hundred of like names; of all of which they only retain in Canada, as it would seem, Holy Grass, applied, as a direct translation to *Hierochloe odorata;* "Herb-John," as in England, to "St. John's Wort" [*Hypericum perfoliatum*]; "St. James' Wort" also applied, as in England, to *Senecio Jacobæa.*

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The name of "Bur Marigold" is also applied to various species of *Bidens*, as in England, to *B. tripartita*, and they give the name of Lady's Thumb to *Polygonum Persicaria*, our "Virgin Mary's Pinch"; which, however, may not have a sacred Christian, but rather a profane origin, this plant being also our "Saucy Alice." All heroical names also have disappeared from the popular nomenclature of Canadian "Farm Weeds." But it is very interesting to find in the Canadian name of Crown weed, given to *Ambrosia trifida*, associated as it is with Kingweed [which latter in the form of "King's Crown," is the English name of *Viburnum Opulus*, and *Melilotus officinalis*] a reminiscence of the true old English names, "Coronation," and "Crownation" [and not the nonsensical "Carnation"], of *Dianthus Caryophyllus*.

Most of our old English picturesque and romantic names of plants have been perpetuated in Canada, and some new ones added, as:—Rainbow, of *Amaranthus tricolor*, our August Flower, and "Florimor"; Fall Dandelion, *Leortodon autumnalis*, our name for which is unnameable; Blue Sailors, *Chicorium Intybus*, our "Chicory"; Blue Devil, *Echium vulgare*, our "Bugloss" and "Saviour's Flannel"; Bouncing Bet, *Saponaria officinalis*, our "Soapwort"; Chinaman's Greens, *Amaranthus retroflexus;* French Weed, *Thlaspi arvense;* King Devil, *Hieracium præaltum;* Devil's Paint Brush, *Hieracium aurantiacum*, our "Grim the Collier"; and Russian Tumble-weed, *Salsola Kali*, our "Glass-wort."

Unnameable names have also been altogether expurgated from the vernacular Canadian nomenclatures; and this is very notable, considering how numerously and widely they still live among the rural communities of England. But they are not a certain criterion of any exceptional coarseness of imagination on the part of the people of this country; while the universal prevalence of such objectionable names in the vernacular languages of India, without the slightest idea among the Hindus, or any but Moslems and our English folk, of there being anything improper in them, would seem to indicate that their existence in England is but a survival of the pagan period of Europe when every natural object of the remotest phallic suggestiveness, in colour, form, etc., was accepted as an apocalyptic symbol of the Almighty Creator of all the material existences through which He is first apprehended by mankind. Like the polygamy, the *harim*, and the "seraglio," of Islam, these, to us, prurient names, have, at least in India, an obvious hieropsychic origin, and are there everywhere still of sacro-sanct significance. The people of the historical East have always looked the Cosmos full in the face, and ingenuously yielded themselves to its every genial impulse as of divine ordination; and as for the opinion of others —*Honi soit qui mal y pense.*

But the most moving interest of "Farm Weeds" is the hope it justifies in the future of the British races in North America; for where British plants, or plants closely allied to them, flourish, and even in greater vitality than in the United Kingdom, there English, and Welsh, and Scots, and the Irish are sure to flourish also. There is no future for any European race in South Africa, for, from south to north, Africa is all a "Black Man's," that is, a true Negro's country. Not even the Semitic race survives there long in the superb condition in which it is found in Arabia, and Anterior Asia; and the tragedy of the Saracens was that they admitted the Negro, and the degenerated, that is negroised Hamites of ancient Egypt into Islam on equal terms with themselves. The Spaniards in their turn committed the similar error in receiving the aborigines of South America into the Holy Catholic Church in an unqualified spirit of Christian brotherhood. The danger before the United States is in the fact that they nearly all lie within the tropical and sub-tropical latitudes of "the Spanish main"; within which all mammals are found of dwindled types, camels as "lamas," lions and tigers as "jaguars," and "pumas," and "ocelots," etc., and aboriginal man as Aztecs. Only in Canada and "the Rockies" do we find the "bison" and the great bears; and all through the latitudes of "the Spanish Main" the European races are found, just as in India, rapidly to Creolise, that is with the very first generation of "the native born"; and in Spanish America, at least, this degeneration of the European Spaniards has been greatly aggravated by their intermarriages with the Christianised descendants of the autochthons of the country. The people of the United States of America, from New York southward, are exposed to the same menace unless they defend themselves against it by the severest immigration, and Negro and Red Man "Reservations" regulations. The intuitive dread of this menace is the true explanation of all the "Negro-baiting" that goes on in the Southern States of the North American Republic; and of the Negro-baiting that prevailed at one time in South Africa, until repressed by the Imperial Government. But in Canada the salubrious severity of the climate, and the strong conservatism of the original religious French and religious Scottish settlers there, are factors full of hope for the future of these two noble races, and of any other races of Northern Europe emigrating to the Dominion; a hope emphatically supported by this official report on its "Farm Weeds." People sometimes talk of the annexation of the Dominion by the United States, but those who will compare these illustrations of European plants naturalised in Canada, with others of the same plants cultivated in the midland and southern States of the United States, will not fail to recognise that in "the course of nature" Canada is much more likely in the far future to annex the United States. And as for this "old country" of our own, Shelley's hypothetical "Transatlantic Commentator" will, of a certainty, never find the ruins of St. Paul's and the Abbey Church of Westminster "a habitation of bitterns." By the betokenings of every wild flower of our own green fields and "tumbled" hedges, we shall go our accustomed way surmounting

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every difficulty to the last, and stand in our hard won lot to the end of time, — time as measured out by the passing physiographical dispensation of this terraqueous globe.

George Birdwood.

Official Report of the Japan-British Exhibition, 1910. London: Unwin Brothers, Ltd.

The Japan-British Exhibition at Shepherd's Bush was acknowledged on every hand to be an unqualified success, and one can hardly give higher praise to the official report than by stating the bare truth that it is a worthy record of a remarkable achievement. In the paper which he read before the Society in January, 1910, Count Hirokichi Mutsu, the Imperial Japanese Government Commissioner, described in considerable detail the steps which were being taken in his native country to get together and transport to London an exhibition representative of Japanese arts and industries. Those who visited Shepherd's Bush know to what an extent success rewarded these efforts, but few probably realised the enormous labour that was entailed. "Great difficulty," says the report, "was involved in bringing from Japan many of the plants and trees required. Some of them were shipped through the Indian Ocean, while others, in order to prevent their premature blooming when passing the tropic climes, were sent by way of America. The extreme hardship to plant life involved in this procedure can be realised when we consider the parallel case that, out of many thousands of goldfish which were brought over from Japan with the greatest care, and were tended by a special skilled attendant on the way, only less than a hundredth part of the number were alive when they arrived at Shepherd's Bush."

Although, perhaps, in other departments the difficulties of transport were not so formidable, still, in view of the enormous distance that separates Japan from London, it speaks well for the organisers of the exhibition that everything was practically complete by the time fixed for the opening. That the exhibition was appreciated is effectively proved by the fact that the number of visitors was over 8,350,000. As to its effects in stimulating trade, Mr. Hikojiro Wada, Commissioner-General of the Imperial Japanese Government to the exhibition, stated that in consequence of it many new markets were opened up for Japanese goods, and over £60,000 worth of Japanese exhibits were sold at Shepherd's Bush. A considerable number of letters from some of the best known furnishing and other firms in London are printed in the report, all bearing striking testimony to the large increases in the sale of Japanese goods in this country.

The report is profusely illustrated with photographs, many of which represent well-known objects both of British and Japanese art.

The Works of Man. By Lisle March Phillipps. London: Duckworth & Co. 7*s*. 6*d*. net.

As the somewhat comprehensive title of this book gives little clue to its contents, it may be as well to state at once that it deals with the consideration of art, or rather architecture, not from the æsthetic standpoint, but "as an expression of human life and character." Mr. Phillipps selects several of the principal styles of architecture—Egyptian, Greek, Arab, Gothic, Renaissance, etc.—and endeavours to show how each reflects the mental state of the nation which produced it. Thus, "the sausage-shaped columns of Egyptian temples and the squat and shapeless entablatures, so blind to all structural purpose, so intellectually unconscious of their relation and proportion to each other, have seemed the mere expression of the state of intellectual insensibility in which they were conceived." In Greek art, again, the awakening which we see, and the revolt from the stereotyped forms of the earlier Egyptians, is the reflection of a mental awakening: the Greek, with his keenly intellectual alertness, was driven, as Professor Ernest Gardner says, "to direct study and observation of nature," whereby sculpture in his hands became individual, flexible, and expressive. Arab architecture, too, with "the whimsically shaped arches, the ingeniously tangled designs, and all the medley of fantastic notions and experiments, tossed together in the flimsiest manner of construction possible," is a direct reflection of the Arab character, "so impulsive, yet so fickle and unstable in all its impulses."

These, and such as these, are the ideas which Mr. Phillipps has elaborated in his volume (of which, by the way, most of the material has already appeared in articles in the *Edinburgh* and *Contemporary Reviews*). Those to whom these ideas are fresh will find much to interest them in the book; while those who wish to carry their study of the subject a little further will be grateful for the bibliography. Mr. Phillipps's selection of authorities appears to be excellent—especially his repeated advice to those eager to understand the Greek spirit, "Concentrate on Professor Butcher." Probably no man in modern times has been more thoroughly imbued with it than the great scholar, and Mr. Phillipps is wise when he writes: "Professor Butcher's works seem to me to give a clearer idea of the Greek ideal in matters of thought and character than any I have met with."

GENERAL NOTES.

Optical Convention, 1912.—It has been decided to hold an Optical Convention and Exhibition of Optical and Allied Instruments in 1912. The objects of the Convention have been defined as follows:—

1. To ascertain and demonstrate the various modes in which (*a*) theoretical science can be

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utilised to further industrial development; (*b*) the study of practical problems can be employed to give direction to theoretical teaching and investigation; (*c*) the practice of experiment can be usefully employed in the teaching of optical science.

2. To bring to the knowledge of the purchaser of optical and other scientific instruments, by means of the exhibition in London, and by means of the catalogue in the provinces, in the colonies, and in foreign countries, what are the resources of British manufacturers.

3. To collect, to ventilate, and to subject to efficient criticism, such proposals as have for their object the better organisation of the British optical industry, and the improvement, in any way, of British optical manufactures.

4. To ascertain and make known existing wants and deficiencies.

The exhibition will be essentially a British exhibition, and will comprise, in addition to a trade exhibition confined to British manufacturers, a loan collection of instruments and apparatus of historical and scientific interest, which may be of British or foreign manufacture, and which shall be selected with a view to subserving the educational and scientific objects of the Convention. Guarantors of £5 and upwards, and donors of £1 and upwards, will be enrolled as Founder Members of the Convention, and entitled as such, in addition to the other privileges of membership, to receive presentation copies of the proceedings and catalogue. The subscription for ordinary membership will be five shillings.

Further particulars may be obtained of the Honorary Secretary, Mr. J. W. Gordon, 113, Broadhurst Gardens, Hampstead, N.W.

Royal Meteorological Society.—The Council of the Royal Meteorological Society have awarded the Symons Gold Medal to Professor Cleveland Abbe, of the United States Weather Bureau, in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual meeting of the Society on January 17th, 1912.

Distribution of the Population in Spain.—Recent census returns show that the density of the population of Spain is only 101 per square mile. Extensive regions in the country are practically unpeopled. For example, in the province of Soria, with an area of 3,836 square miles, and the province of Cuenca, with 6,725 square miles, the number of inhabitants ranges as low as thirty-nine to the square mile. Out of a total of forty-nine provinces, twenty-two figure below the general average for the whole of Spain. They are, with the exception of the province of Huelva, all in the interior of the Peninsula, and once formed the ancient kingdoms of Leon, Aragon, Castile and Upper Andalusia. This group represents a population engaged mainly in agricultural pursuits, although mining and manufacturing are carried on on a small scale. Of the provinces containing more than the general average of population per square mile, Barcelona and Biscaya are the most densely populated, the figures being 383 and 435 respectively. In the more thickly settled provinces the people are devoted to agriculture, and are also largely engaged in manufactures and commerce. With few exceptions the chief centres of population in Spain are situated south of Madrid.

Number of Visitors to the Turin Exhibition.—Since the opening, on April 29th last, to September 19th inclusive, the total number of visitors to the exhibition at Turin was 4,012,776. The influx of visitors during the last few weeks increased considerably. The average number during the first ten days of September reached 48,000 of persons on week-days and over 100,000 on Sundays.

Big Trees in Belgium.—A monograph on trees, lately published in Brussels, gives some interesting facts respecting the size of some of the big trees growing in the forests of Belgium. Of these, the famous "Oak of Liernu," in the Province of Namur, said to be the largest in the kingdom, measures 9 metres (29 ft. 6 in.) in girth at a height of 1·50 metres (5 ft.) above ground. The "Bornival" oak, in the neighbourhood of Nivelles, is 6·20 metres (20 ft. 4 in.) in girth; another near Lummen, 5·20 metres (17 ft.), and the Oak of Charles V. near Brussels, which measures 5·15 metres (16 ft. 8 in.). Amongst lime trees, one at Vosselacre, near Ghent, measuring 6·70 metres (22 ft.) in girth, and another at Bermont, near Huy, of 7 metres (23 ft.), are probably the largest. Of other trees, the so-called "arbre ballon" near Brussels, with a girth of 4½ metres (14 ft. 9 in.), stands 20 metres (65 feet) high.

Cotton Growing in Algeria.—The cotton-growing prospects in Algeria appear to be very encouraging, especially in the Chétiff district, where most satisfactory results have been obtained, thanks to the initiative of some of the leading agriculturists. According to a Marseilles journal, the net profits of this cultivation in Algeria have been as much as from 340 francs to 770 francs per hectare (£5 10*s*. 2*d*. to £12 9*s*. 5*d*. per acre) in bad seasons, whilst as much as 870 francs to 1,200 francs per hectare (£14 2*s*. 2*d*. to £19 8*s*. 9*d*. per acre) has been realised net for the crop. The average net profit in America ranges from 120 francs to 150 francs per hectare (£1 18*s*. 10*d*. to £2 8*s*. 7*d*. per acre), and in Egypt between 95 francs and 110 francs (£1 10*s*. 8*d*. to £1 15*s*. 7*d*. per acre) only. At the present time the area planted with cotton in Algeria is about 1,200 hectares (about 3,164 acres). In the neighbourhood of Orleansville the cultivation of cotton is confined entirely to the irrigated lands. As a result of the introduction of cotton-growing in Algeria, an oil mill for treating the seed has lately been opened at Orleansville.

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THE LIBRARY.

The following books have been presented to the Library since the last announcement:—

Arias, Harmodio, B.A., LL.B.—The Panama Canal. London: P. S. King and Son, 1911. Presented by the Publishers.

Berry, A. J., M.A.—Scotland, Ireland, and Britain Overseas. London: Blackie and Son, Ltd., 1911. Presented by the Publishers.

Briggs, R. A., F.R.I.B.A.—The Essentials of a Country House. London: B. T. Batsford, 1911. Presented by the Publisher.

Bright, Charles, F.R.S.E., M.Inst.C.E., M.I.E.E.—Imperial Telegraphic Communication. London: P. S. King and Son, 1911. Presented by the Author.

Britten, F. J.—Old Clocks and Watches and their Makers. Third Edition. London: B. T. Batsford, 1911. Presented by the Publisher.

Brown, G. Baldwin, M.A.—The Arts and Crafts of our Teutonic Forefathers. London: T. N. Foulis, 1910. Presented by the Publisher.

Clemson, H.—1. Methods and Machinery of Business. Second Edition. 2. Office Procedure and Business Correspondence. London: Butterworth and Co., 1911. Presented by the Publishers.

Cole, F. J., D.Sc.—An Analysis of the Church of St. Mary, Cholsey, in the County of Berkshire. Oxford: B. H. Blackwell, 1911. Presented by the Publisher.

Coutts, H. T., and G. A. Stephen.—Manual of Library Bookbinding. London: Libraco, Ltd., 1911. Presented by the Publishers.

Darling, Henry A.—A Course of Elementary Workshop Arithmetic. London: Blackie and Son, Ltd., 1911. Presented by the Publishers.

de Selincourt, Basil.—William Blake. London: Duckworth and Co., 1911. Presented by the Publishers.

Douglas, Loudon M., F.R.S.E.—The Bacillus of Long Life; a Manual of the Preparation and Souring of Milk for Dietary Purposes. London: T. C. and E. C. Jack, 1911. Presented by the Publishers.

Dudley, Lucy Bronson.—A Writer's Inkhorn. New York, 1910. Presented by the Author.

Dugmore, A. Radcliffe.—Les Fauves d'Afrique photographiés chez eux. Paris: Librairie Hachette et Cie, 1910. Presented by the Publishers.

Edge, J. Harold, F.C.S.—Notes on Practical Cotton Finishing. London: The Trades Papers Publishing Co., Ltd., 1911. Presented by the Publishers.

Fowle, F. E.—Smithsonian Physical Tables. Fifth Edition. Washington, 1910. Presented by the Smithsonian Institution.

Gardner, Ernest A., M.A.—Six Greek Sculptors. London: Duckworth and Co., 1911. Presented by the Publishers.

Gillies, H. Cameron, M.D.—Regimen Sanitatis. Glasgow: Robert Maclehose and Co., Ltd., 1911. Presented by Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

Godfrey, Walter H.—1. A History of Architecture in London. 2. The English Staircase. London: B. T. Batsford, 1911. Presented by the Publisher.

Gould, F. J.—Youth's Noble Path. London: Longmans, Green and Co., 1911. Presented by the Publishers.

Hart, John Hinchley, F.L.S.—Cacao, its Cultivation and Curing. London: Duckworth and Co., 1911. Presented by the Publishers.

Hooper, Luther.—Silk, its Production and Manufacture. London: Sir Isaac Pitman and Sons, Ltd., 1911. Presented by the Publishers.

Inwards, Richard.—William Ford Stanley, his Life and Work. London: Crosby Lockwood and Co., 1911. Presented by the Publishers.

Jackson, William.—Dictionary of English and Spanish Technical and Commercial Terms. London: E. and F. N. Spon, Ltd., 1911. Presented by the Publishers.

Jacobs, Herbert, B.A.—Stevens' Elements of Mercantile Law. Fifth Edition. London: Butterworth and Co., 1911. Presented by the Publishers.

Jameson, P. R.—Weather aud Weather Instruments. Rochester, U.S.A.: Taylor Instrument Companies, 1908. Presented by the Author.

Japan-British Exhibition, 1910.—Official Report. London: Unwin Brothers, Ltd., 1911. Presented by Imre Kiralfy, Esq.

Jerusalem Sous Terre.—Les récentes fouilles d'Ophel, décrites par H. V. London: Horace Cox, 1911. Presented by the Publisher.

John Rylands Facsimiles.—1. Propositio Johannis Russell. 2. "Dives Pragmaticus," London, 1563. 3. "A litil boke for the Pestilence." Manchester: University Press, 1909 and 1910. Presented by Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

Johnson, V. E., M.A.—The Gyroscope. London: E. and F. N. Spon, Ltd., 1911. Presented by the Publishers.

Lamb, Sir John Cameron, C.B., C.M.G.—The Life-Boat and its Work. London: Wm. Clowes and Sons, Ltd., 1911. Presented by the Author.

Laurie, A. P., M.A., D.Sc.—The Materials of the Painter's Craft from the earliest times to the end of the 17th Century. London: T. N. Foulis, 1910. Presented by the Publisher.

Layng, A. E., M.A.—A General Text-Book of Elementary Algebra. Book II. Blackie and Son, Ltd., 1910. Presented by the Publishers.

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Leeming, F. B. — Guide to the Income-Tax. London: Effingham Wilson, 1911. Presented by the Publisher.

Lethaby, W. R.—Mediæval Art. London: Duckworth and Co., 1911. Presented by the Publishers.

Lilienthal, Otto. — Birdflight as the Basis of Aviation. Translated from the German by A. W. Isenthal. London: Longmans, Green and Co., 1911. Presented by the Publishers.

Magnus, Sir Philip, M.P. — Educational Aims and Efforts, 1880–1910. London: Longmans, Green and Co., 1910. Presented by the Author.

Mauclair, Camille.—Antoine Watteau (1684–1721). London: Duckworth and Co., 1911. Presented by the Publishers.

Michell, J. E., M.A., Ph.D. — English-French Unseens. London: Blackie and Son, Ltd., 1911. Presented by the Publishers.

Moore, James M., M.A., and John Slight, M.A. —An Intermediate French Course. Part III. London: Blackie and Son, Ltd., 1911. Presented by the Publishers.

Murdoch, W. H. F., B.Sc.—The Ventilation of Electrical Machinery. London: Whittaker and Co., 1911. Presented by the Publishers.

Phillipps, Lisle March. — The Works of Man. London: Duckworth and Co., 1911. Presented by the Publishers.

Pickworth, Charles N. — 1. Logarithms for Beginners. Third Edition. 2. The Slide Rule. London. Whittaker and Co., 1911. Presented by the Publishers.

Piggott, Sir Francis.—Studies in the Decorative Art of Japan. London: B. T. Batsford, 1910. Presented by the Publisher.

Porter, Robert P.—The Ten Republics. London: George Routledge and Sons, Ltd., 1911. Presented by the Author.

Ranking, D. F. de l'Hoste, M.A., LL.D., and Ernest Evan Spicer, F.C.A., and Ernest C. Pegler, F.C.A.—Mercantile Law. London: H. Foulks Lynch and Co., 1911. Presented by the Publishers.

Richardson, A. E., and C. Lovett Gill.—London Houses from 1660 to 1820. London: B. T. Batsford, 1911. Presented by the Publisher.

Royal Society.—Catalogue of a Collection of Early Printed Books in the Library. London, 1910. Presented by the Royal Society.

Schlich, Sir William, K.C.I.E., Ph.D., F.R.S.—Manual of Forestry. Vol. III. Forest Management. Fourth Edition. London: Bradbury, Agnew and Co., Ltd., 1911. Presented by the India Office.

Spiller, G.—Papers on Inter-Racial Problems communicated to the First Universal Races Congress, London, 1911. London: P. S. King and Son, 1911. Presented by the Publishers.

Stevens, Alfred.—The Wide Range Dividend and Interest Calculator. London: E. and F. N. Spon, Ltd. Presented by the Publishers.

Strachan, Richard, F.R.Met.Soc.—Basis of Evaporation, etc. London: Williams and Strahan, 1910. Presented by the Author.

Tomes, B. A.—A First Course in Practical Mathematics. London: Blackie and Son, Ltd., 1910. Presented by the Publishers.

Tookey, W. A.—How to Manage a Suction Gas Producer. London: Percival Marshall and Co., 1911. Presented by the Publishers.

Tremearne, Mary and Newman.—Fables and Fairy Tales for Little Folk. Cambridge: W. Heffer and Sons, Ltd., 1910. Presented by the Publishers.

Webb, Herbert Laws, M.I.E.E.—The Development of the Telephone in Europe. London: Electrical Press, Ltd., 1911. Presented by the Author.

Webster's New International Dictionary of the English Language. London: G. Bell and Sons, Ltd., 1911. Presented by C. O. Sylvester Mawson, Esq.

Weston, Agnes, LL.D.—My Life among the Bluejackets. London: James Nisbet and Co., Ltd., 1911. Presented by the Author.

Whittaker's Arithmetic of Electrical Engineering. Second Edition. London: Whittaker and Co., 1911. Presented by the Publishers.

Willmott, Ernest, F.R.I.B.A. — English House Design. London: B. T. Batsford, 1911. Presented by the Publisher.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

December 6.—J. A. J. de Villiers, "British Guiana and its Founder—Storm Van 's Gravesande." Lord Reay, G.C.S.I., G.C.I.E., LL.D., will preside.

December 13.—W. Yorath Lewis, M.Am. Soc.M.E., A.M.I.Mech.E., A.M.I.E.E., "Continuous Service in Passenger Transportation."

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

December 14.—J. Travis Jenkins, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal." Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Professor Vivian B. Lewes, "The Carbonisation of Coal." Four Lectures.

Syllabus.

Lecture II. — December 4. — *The Methods Employed in the Destructive Distillation of Coal.*—

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The changes which have taken place during the last century in the forms and settings of gas retorts—The developments of the last ten years and present position of the gas industry—The coke industry and the gradual development of the modern recovery plant—The influence of the retort or oven on the carbonisation.

LECTURE III. — DECEMBER 11. — *The Thermal Conditions existing during the Carbonisation of Coal.*—The heat of formation of coal—The work of Euchene, Mahler, and others—The cause of the endothermic nature of some coals—The thermal value of the reactions taking place in the retort—The losses of heat in a retort setting—The transmission of heat through the retort and charge—The effect of temperature and travel on the primary products of decomposition — The temperatures existing in retorts and ovens—Small charges and full charges—The influences which lead to improvement in the products from full charges, chamber and vertical retorts.

LECTURE IV. — DECEMBER 18. — *The Possible Improvements in Carbonisation.*—The aims of the gas manager and coke producer—Experiments on low temperature distillation and their teaching—The rivalry existing between fully-charged retorts, vertical retorts, recovery ovens, and chamber carbonisation — The intermittent vertical retort *versus* the continuous vertical systems—The Settle-Padfield, Duckham-Woodall, and Glover-West processes—The ideals of carbonisation—The volume of gas due to primary and secondary reactions—The gasification of tar—The limitations of volume and quality of gas—The ends to keep in view in devising new processes of carbonisation.

Papers to be read after Christmas:—

CECIL THOMAS, "Gem Engraving."

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

FRANK WARNER, "Silk."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

CYRIL DAVENPORT, "Illuminated MSS."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

PROFESSOR G. W. OSBORN HOWE, "Recent Progress in Radio-Telegraphy."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Stage Illusion."

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

WALTER SAISE, D.Sc., M.Inst.C.E., F.G.S., "The Coal Industry and Collier Population of Bengal."

NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

ALAN BURGOYNE, M.P., "Colonial Vine Culture."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 18, February 8, March 14, April 25, May 16.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 30, February 27, March 26, May 7.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean-Waves, Sea-Beaches, and Sandbanks." Two Lectures.

January 22, 29.

LOUDON M. DOUGLAS, "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "Hand-Loom Weaving." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

JUVENILE LECTURES.

Wednesday afternoons, at 5 o'clock:—

CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." Two Lectures.

January 3, 10.

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MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "The Carbonisation of Coal. Lecture II. — The Methods Employed in the Destructive Distillation of Coal."

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 6 p.m. 1. Annual General Meeting. 2. Professor Penberthy, "The Present Position of the Tuberculosis Question."

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. Henry Adams, "The Design of Tall Chimneys."

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Mr. W. C. Hancock, "Physical Properties of Clays." 2. Dr. J. Gordon Parker and Mr. J. R. Blockey, "The Value of the Non-tannins in the Formation of Leather." 3. Mr. L. A. Levy, "The Estimation of Carbon Monoxide." 4. Mr. R. G. Pelly, "The Composition of Bassia Fats."

Geographical, Burlington-gardens, W., 8.30 p.m. Sir Alfred Sharpe, "The Geography and Economic Development of British Central Africa."

Victoria Institute, 1, Adelphi-terrace House, W.C., 4.30 p.m. Mrs. Agnes Smith Lewis, "The Genealogies of our Lord in St. Matthew and St. Luke."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor Selwyn Image, "The Meaning and Importance of Decorative Art."

TUESDAY, DECEMBER 5...Roman Studies, Society for the Promotion of, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. R. H. Forster, "The Corbridge Excavations, 1911."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Mr. R. T. Smith's paper, "Electric Lighting of Railway Trains: the Brake-Vehicle Method."

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. C. R. Atkin Swan, "The Simplicity of Telephotography."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Lord Plunket, "The Outlying Islands of New Zealand."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m. Professor J. B. Farmer, "Climbing Plants as a Biological Study."

WEDNESDAY, DECEMBER 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. A. J. de Villiers, "British Guiana and its Founder—Storm van 's Gravesande."

Accountants, Incorporated Students' Society of, 50, Gresham-street, E.C., 6.30 p.m. Mr. A. C. Gillman, "Gas Accounts."

Geological, Burlington House, W., 8 p.m.

Automobile Engineers (Graduates' Section), 13, Queen Anne's-gate, S.W., 8 p.m. Mr. G. M. Junner, "Carburation."

Public Analysts, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., 8 p.m. 1. Mr. J. A. Brown, "The Estimation of Small Quantities of Essential Oil in Spices, etc." Part II. 2. Messrs. L. Eynon and J. H. Lane, "The Determination of Furfural by means of Fehling's Solution." 3. Messrs. J. H. Coste, E. T. Shelbourn, and E. R. Andrews, "The Examination of Petroleum Mixtures." 4. Messrs. G. C. Jones and R. F. Easton, "Note on Ground Almonds." 5. Messrs. C. Beadle and H. P. Stevens, "A Method for Determining the Amount of Insoluble Particles in Raw Rubber." 6. Mr. C. Simmonds, "Note on the Determination of Small Quantities of Methyl Alcohol." 7. Mr. E. J. Parry, "Note on Oil of Male Fern." 8. Mr. E. H. Miller, "The Composition of Australian (Victoria) Milk," "The Composition of Sweetened Condensed Milk," "The Aldehyde Figure of Butter."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel S. A. E. Hickson, "The Development of Our System of National Land Defence."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Professor T. McKenny Hughes, "On Some Sources of Error in Assigning Objects found in Sands and Gravels to the Age of those Deposits, with Special Reference to the so-called Eoliths."

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Dr. F. J. Brislee, "A Redetermination of the Density and Coefficient of Linear Expansion of Aluminium." 2. Mr. V. H. Veley, "The Solution Volumes of Nitric Acid." 3. Dr. J. N. Pring and Mr. J. R. Curzon, "The Influence of the Physical Condition of Metals on Cathodic Over-voltage." 4. Professor H. Marshall, "Notes on Thermostats." 5. Mr. W. R. Bousfield, "Notes on Two Thermo Regulators." 6. Dr. A. C. Cumming, "Notes on Thermostats and Devices used in Connection with Thermostats."

THURSDAY, DECEMBER 7...London Model Abattoir Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Professor Percy Groom, "The Internodes of Calamites." 2. Mr. H. N. Dixon, "On Some Mosses of New Zealand."

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Professor W. Brown, "Psychology of Mathematics."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. P. Power and H. Rogerson, "Chemical Examination of the Root of Ipomosa Orizabensis." 2. Messrs. G. Barger and A. J. Ewins, "The Constitution of Ergothioneine, a Betaine related to Histidine." 3. Messrs. J. N. Pring and D. M. Fairlie, "The Methane Equilibrium." 4. Mr. W. A. R. Wilks, "The Absorption of the Halogens by Dry Slaked Lime." 5. Messrs. W. C. Reynolds and W. H. Taylor, "The Decomposition of Nitric Acid by Light." 6. Messrs. W. C. Reynolds and W. H. Taylor, "Note on the presence of Iodic Acid in Commercial Pure Nitric Acid." 7. Mr. E. P. Frankland, "A method of Determining Carbon and Nitrogen in Organic Compounds." 8. Mr. A. W. Crossley and Miss G. H. Wren, "Derivatives of o-xylene. Part I.—3-Nitro-o-xylene and 3 : 6-dinitro-o-xylene." 9. Messrs A. W. Crossley and G. F. Morrell, "Derivatives of o-xylene. Part II.—Dinitroamino-o-xylene." 10. Messrs. S. Ruhemann and W. J. S. Naunton, "Diphenylcyclopentenone." 11. Mr. H. D. Law, "Electrolytic Reduction. V.—Benzylidene Bases."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. A. Kastner, "The Harp."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. Francis Ward, "Marvels of Fish Life."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Dr. R. Pohl, "Notes on National and International Standards for Electrical Machinery."

FRIDAY, DECEMBER 8...British Foundrymen's Association, Cannon-street Hotel, E.C., 8 p.m. Mr. T. Turner, "Solidification of an Iron Casting in the Mould."

Astronomical, Burlington House, 5 p.m.

Medical Officers of Health, 1, Upper Montague-street, W.C., 5 p.m. Dr. A. A. Mussen, "The Notification of Births Act, 1907."

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Journal of the Royal Society of Arts.

No. 3,081. VOL. LX.

FRIDAY, DECEMBER 8, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 11th, 8 p.m. (Cantor Lecture.) Professor VIVIAN B. LEWES, "The Carbonisation of Coal." (Lecture III.)

WEDNESDAY, DECEMBER 13th, 8 p.m. (Ordinary Meeting.) W. YORATH LEWIS, M.Am.Soc. M.E., A.M.I.Mech.E., A.M.I.E.E., "Continuous Service in Passenger Transportation."

THURSDAY, DECEMBER 14th, 4.30 p.m. (Indian Section.) J. TRAVIS JENKINS, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal." SIR STEUART COLVIN BAYLEY, G.C.S.I., C.I.E., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURES ON "THE CARBONISATION OF COAL."

On Monday evening, December 4th, Professor VIVIAN B. LEWES delivered the second lecture of his course on "The Carbonisation of Coal."

The lectures will be published in the *Journal* during the Christmas recess.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 3rd and 10th, at 5 o'clock, by CHARLES VERNON BOYS, F.R.S., on "Soap Bubbles." (For Syllabus, see p. 102.)

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who require tickets for the course are requested to apply for them at once.

THE INVENTIONS OF JOHN KAY (1704–1770).

By SIR HENRY TRUEMAN WOOD, M.A.,
Secretary of the Society.

Looking through some old papers in search of materials for the history of the Society upon which I am now at work, I was fortunate enough to find some original letters of John Kay, the celebrated inventor, who, after starting a revolution in the textile industry of the world by his invention of the fly-shuttle, died a pauper—it is not known where, but it is believed in France—about 1770, the exact date being quite uncertain.

Besides Kay's letters, which are of special interest, because no specimen even of his signature was hitherto known to exist, there are also letters from his two sons, Robert and William, and a printed document evidently prepared in support of the claims of John and Robert Kay to recognition on account of their inventions, and giving some fresh information about those inventions, together with some interesting details about John Kay himself.

These documents extend over a period from 1764 to 1774. The earlier papers deal with John Kay's invention of the fly-shuttle, and Robert's improvements upon it, including his drop-box. Those of later date refer to John's invention of the machine for making wire cards, and the improvement upon it made by his son William. They all seem to me well worth printing at full length, and I have, therefore, arranged them for publication, together with some extracts from the various minutes of the Society, which I think will serve to make public for the first time the relations which the Kays had with the Society. They do not, indeed, add very much to the meagre amount of information we possess about the great inventor, but they do add a little, and even that little is well worth recording.

The best account of Kay's life is to be found in Bennet Woodcroft's "Brief Biographies of

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Inventors of Machines for the Manufacture of Textile Fabrics," published in 1863. Woodcroft, after some experience as a patent agent, became Professor of Machinery at University College, London, and when the Patent Office was reformed under the Act of 1852, he became first Superintendent of Patent Specifications, and afterwards head of the office, under the title of Clerk to the Commissioners of Patents. He died in 1879. I myself served under him as a clerk in the office for a short time (1870–71), and owed a great deal to his kindly help after I left the office to undertake other work (the greater part of which, indeed, was placed in my hands by himself). He was an enthusiast in all that related to the history of invention, and an ardent collector of everything connected with inventors. He formed the Patent Office Museum, afterwards developed into the engineering branch of the Science Collection at South Kensington, and it is due to him that most of the old machines now in that collection were rescued from the scrap-heap and preserved for posterity. His short life of Kay has provided the material for subsequent biographers. Espinasse includes Kay in his popular "Lancashire Worthies" (1874), but his very readable history includes nothing which Woodcroft had not already printed. The life of Kay by Mr. R. B. Prosser, in the "Dictionary of National Biography," is, like all that careful writer's work, excellent, and if he has not added much to Woodcroft, those who know Mr. Prosser's capacity for painstaking and minute research will realise that there was not much to add. A recent life of Kay, by John Lord, was published at Rochdale in 1903. The author has succeeded in collecting from local sources a great deal of information about Kay's family, and he has shown conclusively that some of Woodcroft's statements are based on inaccurate information; but he has not been able to find anything new about the man himself, except that he has verified the date of his birth (1704), which was before uncertain.

Kay was a prolific inventor. He took out four patents—the first in 1730 and the last in 1745. To none of these patents is any specification appended, though in most of the grants some sort of incomplete description of the invention patented is embodied. The proviso that the grantee of a patent should file a description of his invention was not always included in the terms of the grant at the time of Kay's patent, and when it was inserted it was not always fulfilled. It was in 1733 that he took out the patent for his epoch-making invention of the fly-shuttle, which is, in the opinion of Kay's biographers, and indeed of all experts, the most important improvement ever made in the loom. Before Kay's invention the weaver had to use both hands, throwing his shuttle from one and catching it in the other alternately, or in fabrics which were too wide for the arms of one man to stretch across (broad-cloths) two men had to be employed, one on each side. In Kay's device the shuttle is thrown and caught by a "picker" on each side, and the "pickers" are worked by a cord from each, passing to a short lever held in the weaver's right hand. He is thus able to jerk the shuttle to and fro by the movement of one hand, while the other is left free for the purpose of beating or closing up the weft. The amount of work was doubled, the cloth was of better quality and the labour was diminished. In Woodcroft's words: "Kay's improvements in machinery for weaving continue in use to the present time; they form a part of each loom actuated by power, of which there are tens of thousands in this kingdom alone forming cloths of silk, cotton, linen, and woollen. He was the founder of the first great improvements in the manufacture of cloth, by which employment is now given to hundreds of thousands of people and to millions of pounds sterling." It may be added that Kay's invention rendered possible the construction of the power loom, the great difficulty having been to devise some mechanical means for throwing the shuttle, in substitution for the human hand.

In the cloth trade the shuttle came into immediate employment, but though the weavers were ready enough to use it, they demurred to pay for its use. The woollen manufacturers of Yorkshire formed themselves into an association called "The Shuttle Club," the object of which was to steal the invention and to defraud the inventor of his legitimate rights by defending actions for infringement. This laudable association was eminently successful, for it succeeded in ruining Kay, while making full use of his invention. The employers were well backed up by their workmen, who broke into Kay's house, destroyed its contents, and only failed in killing Kay himself.

Kay was by trade originally a reed-maker, and he is credited with the first idea of substituting wire for the thin strips of cane or reed from which the "reeds" took their name. They may be regarded as the teeth of the comb or grating, in the interstices of which the threads of the warp pass, so that by the swinging of the frame in which the reeds are set, each successive

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thread of the weft is pressed into its place between the warp threads, and the whole fabric rendered close and compact.

The use of wire for reeds is believed to have been his earliest invention. It was not patented. Of his numerous other inventions, some patented and some not, few appear to have been of any value. Only two seem to have been of importance—his fly-shuttle and his machine for making cards for carding wool and other textile fibres.

THE "WHEEL-SHUTTLE."

We may now proceed to consider the papers relating to improvements in weaving appliances by John and Robert Kay.

In the minutes of the meeting of the Committee on Correspondence, held February 6th, 1764, we find the entry: "A letter from Mr. Robt. Kay concerning an improvement on the wheel-shuttle. Resolved that it be referred to the Committee of Mechanics." In the minutes of the Committee of Mechanics for April 19th, 1764, the following minute occurs:—

"Took into consideration the reference to this Committee from the Committee of Correspondence of April 6th* of Mr. Robert Kay's improvement of the Wheel Shuttle. It was Resolved that Mr. Kay's shuttle should be tried, and that Mr. Thomas Moore of Chiswick Street be requested to make a tryal of it."

Mr. Moore was a carpet manufacturer, and he received in 1757 the first prize of those offered by the Society for "making carpets in England on the principle of Turkey carpets." He does not seem to have made any report —at least, I cannot find any—and Kay wrote again to the Society a letter, which is referred to in the minutes of the ordinary meeting of September 19th, 1764, where it is stated that a letter from Robert Kay on the wheel-shuttle was referred to the Committee of Manufactures. (The functions of the two Committees, Mechanics and Manufactures, seem to have been rather mixed together.)

In the minutes of the Committee of Manufactures of December 4th, 1764, it is stated:—

"A letter from Robt. Kay, of Bury, Lancashire, was read concerning his Wheel Shuttle, which was delivered by the Committee to Mr. Thomas Moore for tryal, desiring to be informed what had been done with regard to it. Resolved that the Secretary write to him to acquaint him that the Committee do not know any person who understands the manner of using his Shuttle, and to desire him to give the fullest instructions concerning it."*

A letter to this effect was evidently written by the secretary, Dr. Templeman, and here is Robert Kay's reply:—

Bury, Lancashire.
Decr 8th, 1764.

SIR,—Yours of the 4th inst. I rec'd, in answer I very much question whether or no the Committee will be able by any instructions that can be given by Letter to try the utility of the Wheel Shuttle, for notwithstanding the simplicity thereof it may be missed by a Person unacquainted therewith, not only so, but it requires some little practice before a person unacquainted with the Wheel Shuttle can weave so as to shew the advantage of the Wheel Shuttle in its true light, for want of which the Wheel Shuttle might not be so well thought of as it deserves and might be an hindrance to the Wheel Shuttle being made use of in several Branches in which it wou'd be of real service, and which I doubt not wou'd be contrary to the Intent of the Society.

It is through the above considerations that I wou'd hereby propose to the Committee whether or no it wou'd not be best to have the Brass Wheel Shuttle try'd in Bolton where great numbers of wood Wheel Shuttles are used in several Branches of the Cotton Manufacture from half-yard wide upwards and from whence the Committee might have a report made concerning the utility of the brass Wheel Shuttle, attested by such persons in Bolton or may be in Manchester, as the Committee shou'd chuse, after which the Slay or Lathe (being the only part of the Loom which undergoes any alteration) with the Fixtures and shuttle as it was when Wove with might be sent up to the Society for their Inspection and to serve as a Pattern to any one who might think proper to use the Wheel Shuttle.

If the above proposal be agreable to the Committee shou'd be glad to have the Brass Shuttle sent down and will sett about it, if not shou'd be glad of a line from you and will give the fullest Instructions in my Power relative to fixing the Wheel Shuttle for weaving, and am

Yr. h'ble. Sert.
ROBT. KAY.

This letter is preserved in one of the Society's old guard-books, into which were pasted a selection of the letters which appeared worth preservation, and a vast number of miscellaneous documents relating to the Society's operations.

* There is something wrong about this date, for the meeting of April 6th was an ordinary meeting of the Society, not a committee meeting, and the minutes contain no reference to Kay's letter. However, this is unimportant.

* It has always been known that an application had been made to the Society by, or on behalf of, Kay, and Woodcroft printed extracts from the minutes of April 19th and December 4th. He, however, thought that one of the letters was from John Kay, and did not realise that any more was involved than the original invention of 1733.

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Not infrequently, when a communication was received which a committee obviously considered unfit for any other treatment, it was resolved that the correspondent be thanked, and his letter "preserved in the guard-book." These books consequently contain a great many papers of interest and a huge mass of rubbish, which, if it has become venerable by age, has gained no fresh value by its preservation for a century and a half. There are twenty-seven of the volumes, for the period from 1754 to the year 1782, when the Society began to publish *Transactions*, and it may, therefore, be realised that a search through their contents is a task requiring some courage and a good deal of perseverance.

In the same book are also the two letters from John Kay printed at the end of this article (page 81), and the statement headed "Some Considerations on the Improvement of Weaving Chequer'd and Strip'd Goods," printed on page 83.

The contents of the guard-books are not in strict chronological order, but papers of about the same date are nearly always close together, and they seem to have been pasted in the books as they were dealt with by the various committees. It may, therefore, be taken as quite certain that John Kay's letters and the "Considerations," etc., were received by the Society about the same time as Robert's letter of December 8th, 1764. They do not bear any date themselves, or any indication of a date or address. The only suggestion of a date is that John Kay refers to his invention of a tape loom as made "twenty-two years ago." This was patented in May, 1745, and may well have been invented two years before it was patented.

John's letters give no information whatever about his famous invention, and it is not very obvious why they were sent to the Society; but the writer was then old and very poor, and doubtless he hoped for some grant to be made him on account of one or other of the inventions he describes. They are evidently not in his own writing, and apparently not in that of Robert; but he signed both the letters, and also the two enclosures in the second letter, and the discovery of four autographs of the inventor of the fly-shuttle, when, so far as I have been able to ascertain, none was known to exist, ought to appeal to all who are interested in the history of invention.

It has always been known that a letter had been addressed to the Society by Kay. A portion of one of his letters—the last paragraph of the first letter—has already been quoted by Woodcroft, and again by Prosser, as having been printed in an anonymous book published in 1780, under the title of "Letters on the Utility and Policy of Employing Machines to Shorten Labour." Mr. Prosser says the records of the Society of Arts do not afford "any corroboration of Kay's communication." Such "corroboration," however, has now been discovered.

The "Considerations" does appear to me to be a document of greater historical value. It gives a certain amount of new information about Kay's original invention, and also, as I shall try to show presently, about his son Robert's own inventions, and it adds a good deal to what has already been recorded about Kay's attempts to obtain in France the recognition and the rewards which his own country refused him. It is apparently drawn up by Robert, who was evidently a better man of business than his father, and also, if the document was entirely his own composition, by no means an unskilful writer. The account of Kay's successful efforts to obtain, at all events, the promise of a pension are interesting, and quite in accord with what is known of the practice of the French Court. It was easy for any applicant who was properly recommended to obtain a grant of a pension from the King, and it was not very difficult to get the grant registered, which was the second step; but when it came to payment, it was quite a different matter, and a great deal of influence was required. So Kay seems to have found, and it was probably the breaking out of the Seven Years' War in 1756 which ruined whatever chances he may have possessed. Ill-luck pursued him on the other side of the Channel as on this. Whether he really went back to France and died there seems more uncertain than ever, but about this there will be a little more to be said later on.

I have been able to find nothing more, either in the guard-books or in the minutes after the receipt of Robert Kay's letter of December 8th, 1764, and there the matter appears to have dropped. No copies of the letters sent out from the Society were preserved, and there is nothing to show whether Robert Kay ever received any reply to his communication. It certainly does not appear to have been formally considered by any Committee, or at all events no record of such consideration can be traced. Nor have I been able to discover in any of the minute books any reference whatever to John Kay's letters, or to the printed memorandum. In fact, the narrative ceases abruptly. That this should be so is a very great pity. The Committee missed a great opportunity of doing honour to the Society

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by including in the list of those who received its awards the name of one of the greatest of English inventors, that of John Kay, the inventor of the fly-shuttle, the father and founder of the British textile industry.

It has always been assumed that the invention submitted by Kay to the Society was the original invention of the fly-shuttle. This on the face of it was highly improbable, because the Society certainly would not have been likely to have given any prize to an invention thirty years old, and one which appears to have attained in that time but a moderate measure of success. It was also strictly contrary to the Society's regulations to give any prize whatever to a patented invention; and this alone would certainly have been enough to prevent the Committee paying any attention at all to a device which, whatever its merits, it must be remembered was in existence just twenty years before the Society itself was founded.

That, in spite of its great merits, the fly-shuttle was not well known or generally used in 1764 seems certain. Guest and, following him, Baines, in their well-known histories of the cotton trade, both say that the fly-shuttle did not come into use in the cotton trade till about 1760, and before that date it was certainly only in the woollen manufacture (not a London industry) that it had been employed. It was, therefore, natural enough that no weavers could be found in London to work it, and Robert Kay evidently realised this when he suggested that the invention should be tested in Bolton or Manchester, where plenty of workmen could be found who were familiar with its use.

But it appears to be quite clear that the invention brought before the Society was not the original fly or wheel-shuttle of John Kay, but his son Robert's improvements upon it. This is stated in so many words in the minutes of the Committee meeting of April 19th, 1764, which says that the matter referred to them was "Mr. Robert Kay's Improvement of the Wheel-Shuttle." From the "Considerations" it appears that these improvements were intended to adapt the shuttle to the weaving of striped or chequered fabrics, and it is added that the stripes were not lengthwise, in the direction of the warp, but crosswise in the direction of the weft (obviously for a chequer pattern the warp also would consist of yarn of different colours arranged in strips). Now this was the object of Robert Kay's invention of the drop-box (brought out about 1760), a device by which the weaver could bring into use any one of three different shuttles, each containing a different coloured weft. This drop-box of Robert's is always stated to be the first device for weaving cross-striped fabrics conveniently, without stopping the loom to change the shuttle, or to re-charge it with a different coloured weft, and if it be permissible for one who is without expert knowledge to express a very positive opinion on such a subject, I may say that it appears to me certain that Robert Kay's "Improvements on the Wheel-Shuttle" consisted of the addition of his own drop-box to his father's fly-shuttle, and that this is the only theory which satisfies all the statements made in the papers brought before the Society's Committee and now first published. There may also have been other alterations; indeed, Robert says that the new shuttles are to be made of metal—brass or iron—instead of wood.

Robert also refers in the "Considerations" to his invention for weaving two pieces of narrow goods simultaneously. This he does not describe. It may have been a device similar to that embodied later in the "tape-looms" or "riband looms," used in Coventry and elsewhere.

There can, I think, be no doubt that the appliance called a "wheel-shuttle" by the Kays was that now known as the "fly-shuttle." The last name never seems to have been used by the inventors. The anonymous author of the pamphlet previously mentioned, "Letters on the Utility and Policy of Employing Machines to Shorten Labour," published in 1780, who seems to have known Kay, or, at all events, to have known a good deal about him, speaks of the wheel-shuttle, and the first recorded use of the term "fly-shuttle" is by Dr. John Aikin, in his book on Manchester (p. 300), published in 1795.* The same writer, in another passage (p. 267), uses the phrase "wheel or flying shuttle." It is possible that the word, like so many technical terms, was originally invented or used by the workmen, and did not for a long time get into print. Kay's original shuttle certainly had wheels, as is shown by the description in his patent of 1733, for although no actual specification was enrolled, the letters patent contain a general description of his invention. The shuttle was stated to be:—

"For the better and more exact weaving of broad cloths, broad bays [baize], sail cloths, or any other broad goods, woollen or linnen, which shuttle is much lighter than the former, and by running on four wheels moves over the lower side of the webb or spring, on a board about nine feet long,

* Murray's Dictionary *s.v.*

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put under the same and fastened to the layer, and which new contrived shuttle, by the two wooden tenders, invented for that purpose and hung to the layer, and a small cord commanded by the hand of the weaver, the weaver sitting in the middle of the loom, with great ease and expedition by a small pull at the cord casts or moves the said new invented shuttle from side to side at pleasure, and also strikes the layer by his pulling it in the middle uniformly over the piece, makeing it unavoidably even and much truer and better than by any method heretofore used."

It may be that the inventor himself regarded the application of wheels to the shuttle as more important than the device for actuating the shuttle, and hence the name by which he refers to the invention. I have not myself sufficient knowledge of the highly technical subject of weaving to speak definitely about any modern appliances, but I am informed that though wheel-shuttles are sometimes used for weaving heavy goods, ordinary shuttles are not fitted with wheels or friction rollers.

The Wire-Card Machine.

We now come to Kay's machine for making wire cards, upon the history of which also some new and fresh light is thrown by the Society's records.

The preparation of wool for spinning was at the time all done by hand, as it is even now to a very limited extent in the domestic production of genuine homespun goods. The carding engine, though machines for the purpose had been proposed by Bourn in 1748, and by Paul a little later, was really first introduced by Arkwright in 1775, and improved by him ten years afterwards.

The hand cards used may be described as stiff wire brushes. The wires are fixed in a tough leather backing, which is supported by a further backing of wood. Two of them are employed in the process of carding, the lock of wool being laid upon one and combed out with the other. The result is to straighten out the fibres—a process required in all materials used for the manufacture of textiles, except silk, which is produced as a natural thread. The sliver produced by the action of carding is ready for the spinner, who spins it into a thread.

The object of Kay's invention was to facilitate the production of these cards. There is in the engineering collection belonging to the Victoria and Albert Museum what is believed to be an original example of Kay's machine. The history of this particular machine is a little obscure, and it is not known whether it was one of John Kay's machines or an improved machine constructed at a later date. From the evidence now available, it seems hardly questionable that it is really a later form, for it is to be noted that in it the whole process is carried out in one machine, whereas Kay himself says in his description, quoted below, that he used two "engines," one to make the necessary perforations in the leather for holding the wires, and the second to cut the wires to the requisite length and to bend them so that they are securely held in position. The remainder of the work, the fitting of the wires in place, was to be done by hand. The catalogue of the South Kensington collection gives a very clear description of the machine, but it does not all correspond with the account given by John Kay, or with that given by his son William.

It does, however, agree with the account of Kay's machine given in "A Description of the Country from thirty to forty miles round Manchester," by J. Aikin, M.D. (1795), p. 267. Here it is to be noted that the invention is attributed to Robert Kay. If Robert improved his father's machine, it seems likely that the South Kensington example may be one of Robert's machines, in which case it is nearly as interesting and valuable as if it had been the actual apparatus of John Kay himself. The following is the passage in which the machine is described; it occurs in that part of the volume devoted to Bury:—

"The inventions and improvements here in different branches are astonishing. One of the most remarkable is a machine made by Mr. Robert Kay, son to the late Mr. John Kay, inventor of the wheel or flying shuttle, for making several cards at once to card cotton or wool. The engine straightens wire out of the ring, cuts it in lengths, staples it, crooks it into teeth, pricks the holes in the leather, puts the teeth in, row after row, till the cards are finished; all which it does at one operation of the machine, in an easy and expeditious manner, by a person turning a shaft, and touching neither the wire nor the leather."

The catalogue also gives 1750 as the date of the invention by Kay, and adds that card-making machines did not come into use until fifty years later, when they were introduced in an improved form by Amos Whittmore.

In November, 1765, the following letter from John Kay was received by the Society:—

Gentlemen,—I have observed that the only method to make good woolling and cotton goods is by the wooll and cotton being well carded for the spinner and without that the goods cannot be well manufactured.

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I have for a long time taken notice that the present method of making of woolling and cotton cards is attended with great difficulty and expence and but few of the Cardmaker's that makes the cards to that perfection as are fit to be made use of, and the method they make them in, is, very slow, which makes the price of cards very high, so that they often make use of them too long, which breacks the stable of the wooll and the cloth, and cotton, are much damag'd for that reason.

Now I have invented and made two Engines which I have for a long time experimented for makeing of woolling and cotton cards, the one for pricking the leather's and the other to cut and bend the wires that is to be put into the leather's, now pricking the leather's and making the wires is all the diffeculty and teadous work in card making: the rest is children's work or may be done by any hand, and children of twelve or fourteen year's of age is more proper to work these Engines that I have made then grone up person's so by this method it is unnecessary to be at much expence of men's laber; and by these Engines as much work may be done by one person in one day, as in the method heather to precticed can be done by one person in twelve days and to that degree of perfection as cannot be done in the preasent method so that if these Engines was to be put forward, they would be of great advantage to the woolling and cotton factorys in this Kingdom for the reasons above mention'd.

from your humble servant

John Kay

In the Talbot Inn Yard in the Borough Southwark
Novr. 27, 1765.

The original of this has fortunately been preserved. Like Kay's other letters, it does not seem to be in his own writing, but it is signed by him. It is endorsed on the back as "Referred November 27th, 1765."

This letter was considered at a meeting of the Committee of Manufactures held on January 7th, 1766, the following being the minute relating to it:—

"Took into consideration Mr. John Kay's Engines for making Woollen and Cotton Cards.

Mr. Kay's letter was read, Mr. Kay attended, and his Engine for cutting, doubling, and crooking Cardmakers Ware [? wire] was produced and worked.

The Committee inspected the Pricking Engine in the Machine Room.

Adjourned to Thursday next at 6 to consider further Mr. Kay's Engines."

From this it is quite clear that Kay used two separate machines, and that the two machines were shown to and tested by the Committee. It should be remembered that the Society was then occupying the house opposite Beaufort Buildings, in the Strand. The machine-room referred to was the large room on the ground floor in which the collection of models and machines was preserved.

The consideration of Kay's apparatus was taken up again at a meeting of the Committee, held two days later, on January 9th, 1766, as recorded in the following minute:—

"Resumed the consideration of Mr. Kay's Engines.

Mr. Kay attended and answered such questions as were put to him.

Resolved it is the opinion of this Committee that the Machines produced by Mr. Kay for cutting, doubling, and crooking the wire and for pricking the leaves of cards for the use of the Woollen and Cotton Manufactures are very ingenious, and well contrived for facilitating that branch of business.

Resolved that six pair of Cards be made from wires crooked and leaves pricked by Mr. Kay's machines, in order to enable the Committee to ascertain the merit of those Engines, and that Two Guineas be advanced Mr. Kay towards his furnishing the wires and leaves."

There is also a note in the minutes of the Committee of Correspondence of January 6th, 1766, that:—

"A letter signed John Kay, without date, concerning a loom was read. Ordered to be referred to the Committee on Manufactures."

There is nothing to show what this letter was really about, or whether it was ever dealt with. It has not, so far as I can find, been preserved. It may have contained further details about his wire-card machine, or it may have referred to some other of Kay's numerous inventions.

I have been unable to find any record of any further correspondence with Kay, or any further evidence that the Committee had the machine before them again. Whether Kay made the cards or took any further action in the matter seems absolutely uncertain. From this date the Society's records yield no further information about him. Indeed, this is the latest known reference to Kay in existence, and it has this peculiar value—that it shows him to have been living in 1766, a fact of which there was no previous proof, though he is believed, on very slight evidence, to have gone a second time to France and to have died there.

Eight years later, after Kay himself was dead, we again find his machine coming before this Society, and the way this was brought about is not a little curious.

On June 7th, 1774, the following letter was

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received from Mr. Nathan Fielding, of Boston, New England:—

Boston, New England,
April 27, 1774.

SIR,—I hope your goodness will pardon me for troubling you with a Letter, as I always accknowledge it my Duty to be of service (when in my power) to every one that study the Arts and Siences, and I knowing that your Great and worthy Society always give Due encouragement to all Ingenuity, have taken the Liberty to send you a few lines, to accquaint you that I am now at Boston, New England. I have had the pleasure of meeting with one Mr. Joseph Pope a very Ingenious man, he has invented a Machine for cutting and crooking wire for card's teeth, which any boy of 10 years old, with this Instrument will, Cut, Staple and crook 10lb. wt per Day with ease, . . . the Machine is so simple a construction that I wonder it has not been long in use, (as I cannot remember ever hearing of any such thing) besides of Little cost according to its merit and will do of all sorts of teeth from the finest to the coarsest, and if that none have apply'd to you About any such thing I hope that the said Mr. Pope will meet with ample satisfaction for his trouble.

I humbly beg you will give the said Mr. Jh Pope an Answer to this Letter and Direct to him, Clockmaker Southend Boston, New England, and I shall always accknowledge it the greatest favour Done to your humble Servant

NATHAN FIELDING.

Mr. Fielding was not a member of the Society. This letter was referred to the Committee of Mechanics, and it was brought up at a meeting of this Committee on October 27th, 1774. It was then postponed for consideration to the next meeting. This next meeting of the Committee was held on November 3rd, 1774, when we find the following minute:—

"Resumed the consideration of the letter on a machine for making cards for wool and cotton.

Mr. Kay attended, and informed the Committee that he had used a machine upwards of ten years for this purpose invented by his father by which he can cut double and crook fifteen pounds p. day.

The Committee examined the Minutes of the Committee of Manufactures dated January 7th and January 9th, 1766, on Mr. Kay's machine.

Resolved that Mr. Fielding be informed that Mr. Pope's Card Engine is not new and that a much better machine for that purpose was offered to the Society many years since.

Resolved it is the opinion of the Committee that the Society proceed no further in this business."

It may be assumed that the Mr. Kay mentioned was invited to attend the Committee in consequence of his knowledge of the subject, as was the usual practice at the time. On November 9th, 1774, the following letter was received from him, and it appears from it that he was William Kay, the youngest son of John.*

SIR,—The countenance I receiv'd from the Committee on wednesday evening Last, & my not being aquainted with the form of a regular Petition & that Glossy Language which adds Great Lustre to Truth & is very necessary to cover the face of Fiction, I Presume without any prelude or form, to aquaint you with they Following facts, praying you to Lay them before they honourable Committtee.

I being the only person that has work'd & made Publick the Engine for Cutting doubleing & crookening of wire for wooll & cotton cards, & also the Engine for Pricking the Leathers, the original & first Idea I acknowledged to be the Invention of my Father (Jno. Kay) but from my Constant working them for upwards of eight years, I have found, and made several Improvements which renders them to work much Quicker, & more Perfect, & I flatter myself I have a few at work in great perfection, the advantage gain'd by these two Engines is more then six to one beside their superiority in the work . . . . Cards by the help of these Engines cannot be made otherwise then True and every Tooth even, & of the same length; which is impossible to make the old way, & when they are not even but one tooth Longer then another, they break the Staple of the wooll which is a Great prejudice to Cloth.

If I am honour'd with a call to attend they Committee I shall Take pleasure in ascertaining what I have advanced, to their general Satisfaction, Should they then View the advantage in the same Light I do, & favour me with their sanction & Encouragement I will too the utmost of my ability & power Vend & Publish them for the general Utility & Benefit of the Community & am Sir yr. most obt. & hble.

Servt. WM. KAY
No. 11 Tooley Street
9th *November* 1774.

This letter was considered at a meeting of the Committee held on December 1st, 1774. The record about it runs as follows:—

"Took into consideration the letter from Mr. Kay on a Machine for Making Cards for Wool and Cotton.

Read the letter, and Mr. Kay attending was called in and says that the Improvement he has made in the Machine makes it ½ value more than his fathers.

That his machine is adapted to prikh the twill way i.e. the lines in which the wires are fixed are prickt diagonally, by this means the Wool is cleared of any lumps and made fine and levell for Spinning.

* According to Lord's Memoir (p. 135), William was born in 1765, but this must be incorrect. He is also stated to have died in 1783.

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Mr. Kay being ask'd wether he would produce his Machine to the Committee at their next meeting for their inspection

Answer'd He would.

Postponed the further consideration."

The Committee met again on December 8th, 1774, and

"Resumed the consideration of the Machine for cutting, doubling, and crooking wires for cards for wool and cotton postponed at the last meeting.

Mr. Kay attended and worked the engine in presence of the Committee as also his engine for pricking the leathers.

Mr. Kay being asked what improvements he had made since the machines were produced to the Committee in the year 1766,

Answered that he has invented the scrip and twill way for pricking the leaves which are the only ways for wool and cotton.

Being asked who first invented this kind of machines,

Answered his father John Kay.

Was this business done by hand before his father's invention,

Answered, Yes always, and he never knew of any machine.

Whether his father ever brought it so far in use as to make cards for sale—Answered, Never.

Did he himself ever make cards for sale by his Engine—Answered, Yes.

Says he has reduced the price of cards on an average 30 per cent., and that this reduction is owing to the engine, for the materials are much advanced in price.

Mr. Kay says that his engine is made chiefly of iron and steel, and that he now hangs by treddles the weights which steady the work by which the machine is kept in constant order, whether working quick or slow, whereas his father's engine being made principally of wood, and the weights not being properly hung, was liable to be out of order and make the work irregular.

Ordered that Mr. Cook, Rug Maker, in Black Lyon Yard, Whitechapple, be wrote to and desired to attend the Committee at their next meeting, if convenient, or inform the Committee by letter whether he makes use of cards made by Mr. Kay, whether he thinks them equal or superior to cards made in the old way, and how much the price of cards has been reduced by this machine.*

Postponed the further consideration."

The matter was finally dealt with at the meeting on December 15th, 1774, as follows:—

"Resumed the consideration of Mr. Kay's Machine for making Cards for Wool and Cotton.

Mr. Cook attending according to the request of the Committee at their last meeting inform'd the Committee that Mr. Kays Cards are better for his Use and made more true than any other. That they are cheaper as he now buys for 2/6 what is still sold by other Cardmakers at 3/ and what he used to give 3/6 and 4/ for.

What is Mr. Cook's opinion of the Cause of this Reduction of the price of Cards

Answer'd, He believes it to be owing to the Contrivance of the Machine by which they are made Quicker and more true.

Being ask'd, Whether the Staple of the Wool is better preserved by Mr. Kay's Cards than any other

Answer'd, A great Deal for Mr. Kay's Cards draw it out to its full Length whereas the others frequently break it.

The thanks of the Committee were returned to Mr. Cook for his obliging Attendance on the Committee.

Resolved it appears to the Committee from the Inspection of the Machine when at work and from the Information of Mr. Cook given to the Committee this Evening that the Invention is a Matter of Great Utility to the Public.

Resolved to recommend to the Society to give a Bounty of Fifty Guineas to Mr. Kay."

This resolution was confirmed by the Society, and the award is recorded in the Register of Premiums and Bounties published in 1778. It is also included in Dossie's list ("Memoirs of Agriculture," Vol. III. p. 458), but in that list the name is erroneously given as Ray. It is very likely in consequence of this misprint that no mention, so far as I can find, has ever been made of an award being given by the Society for Kay's machine for making wire cards, since Dossie's lists were always regarded as official, and he had the general authority of the Society for the papers he published, if not their express sanction for the lists of awards.

In conclusion, I may point out that the way in which William Kay refers to his father seems to indicate that he had been dead for some little time. This fact, and the fact that he was alive and in London in 1766, render it extremely probable that he died not much before or much after 1770.

APPENDIX.

I.—Letters from John Kay—(Probable date December, 1764).

(No. 1.)

Gentlemen,—Twenty-two years ago by the desire of Mr. Joseph Stell, of Keighley in Yorkshire, I invented for his tape lomes to weave by water which Mr. Stell had a patent for which was got in my name because Mr. Stell could not make oath that he invented it; there is one of these Engines at work by water near Manchester by the permission of Mr. Stell, since these Engines as been at work I have made a great improvement in the said Engine by model.

* Cook was not a member of the Society.

Also there is a invention for spining of cotton by water, but as the Engines was very expencif to make and keep in repair so that the profit by this invention is very little; now I have contrived to lay by most of the great expence of making and repairing the Engine and to perform with more ease and in a simpler manner and the yarn much better.

I have great many more inventions then what I have given in and the reason that I have not put them forward is that twenty years ago by the bad treatment that I had from woolling and cotton factres in different parts of England and then I apply'd to Parlement and they would not assist me in my affairs which obliged me to go abroad to get money to pay my debts and support my family.

from your humble servant
John Kay.

(No. 2.)

Gentlemen,—the other day I was taking notice of the drill plough which I think is very imperfect in several partes which I can improve very much; also I can make a good improvement in the plough that plough's sowes and cover's at once; likewise a good improvement in the two handed wheel for spining wool but the method will not be of any servis in spining of lining cotton and silk; likewise a plough may be made practiable to cut drean's in marshe land and in makeing canals or sluses for navigation as Duke of Bridgwaters cut near Manchester; it is my opinion that two men and four horses with a common plough whould plough up as much soil clay or gravel as twenty four men whould dig up in the time and while the men are throwing it out the plough might be at work at a little distence from they men; by shuch a method great expences might be saved in great undertakeings and the navigation finish'd in much less time.

from your humble servant,

John Kay

Enclosures with No. 2.

A method to regulate fire to anne degree of heat which will be valuble for distilling, chymistry, making of steel, pressing of woollen goods, and green houses.

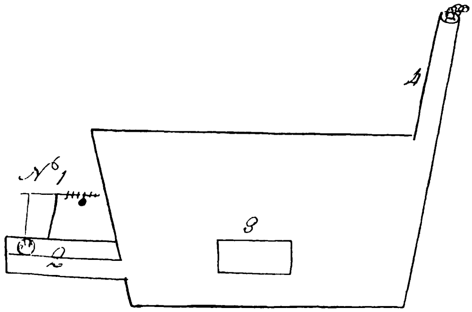
In distilling sometimes the fire rises so high which causes the spirit to blow the top of the still of which sets fire to the house which is often to be seen in the nuse papers.

The chymisters by there fire being to hoot causes there glases to brack which makes there loss considerable.

In makeing of steel it is by keeping a furnace to certain heat wherein the Iron is lad in; for a bout three days and three nights. If the furnace is a little to hoot it melts the Iron which makes the loss great, and if the furnace is not to such a degree of heat the steel is not good.

In pressing of woollen goods if the fire under there pleat be not a certain degree of heat the cloths or stufes are not well pressed and then the are not fit for seal, and if the fire rises a little to high the goods are often burn'd.

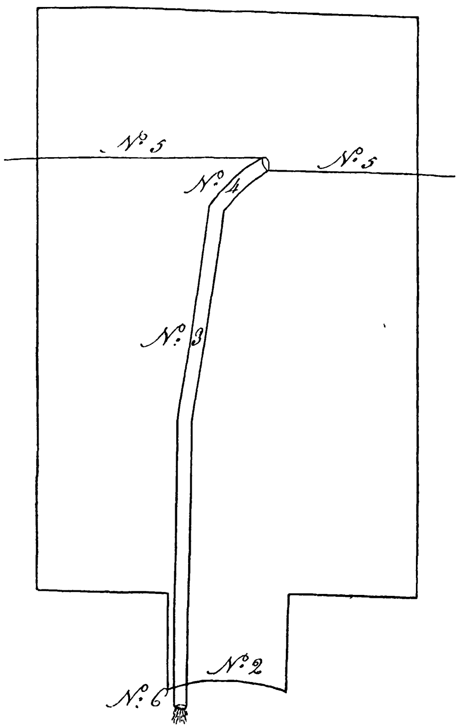
And in the green houses they chowse them to one degree of heat.



No. 1—Regulator. No. 2—A pipe to furnish the draft with hare. No. 3—The door to put the cole in. No. 4—The draft pipe.

If the Committee of Michinicks do not understand my drawing I am redy to explain to anne of them by words; the method is simple and will prevent the misfortens before mentioned.

from your humble servant
John Kay.



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A method to clean docks for Shiping; No 1 is supos'd to be the dock; No. 2 the gates; No. 3 a pipe of wood six inches wide and the sides dresed to half a inch for lightness; that parte which is No. 4 is made of leader with Iron hoops to keep it open; No. 5 is a rope by which a man on each side the dock pules No. 3 from one side of the dock to the other; the nose of No. 4 is keept down to the mud by a weight then the piller of water that lyes a bove forces the mud into the pipe which runs out at No. 6.

Several other articles is belonging which cannot well be explain'd but by words; the method is simple with little expence and much wanted.

from your humble servant,

JOHN KAY.

II.—SOME CONSIDERATIONS ON THE IMPROVEMENT OF WEAVING CHEQUER'D AND STRIP'D GOODS.

Whereas by a Wheel Shuttle, invented by *John Kay*, late of *Bury*, in *Lancashire*, great Advantages have arisen to the Publick, by Means of broad and narrow Goods, not strip'd in the Weft, being wove in a more easy and expeditious Manner, than heretofore practised; some of the particular Advantages of which, in the Cotton Manufacture, are underneath set forth, by which it may be understood, what Advantages may arise to Chequer'd and strip'd Goods, by the Wheel Shuttles being used therein.

1st, In Cotton Goods of Half Ell wide, it's found by Experience, that a Weaver may gain fourteen pence by the Use of the Wheel Shuttle, as soon as One Shilling by the Use of the Hand Shuttle; and in Yard-wide Drawboys, Indian Jeans, &c., it's likewise found by Experience that a Weaver may, by the Use of the Wheel Shuttle, gain sixteen pence, as soon as One Shilling by the Use of the Hand Shuttle, for the following Reasons: The Spool, Pin, or Quill (upon which the Weft is Wound) used in the Wheel Shuttle, will contain five Times as much Weft as the Spool, Pin, or Quill, used in the old Way in the Hand Shuttle, by which Means there's not the Necessity of stopping the Loom so often by four Times, when the Wheel Shuttle is in Use, as in the old Way when the Hand Shuttle is in Use, and consequently not so much Time lost; likewise the Cloth must infallibly be better, by not having so many Pieceings in the Weft; likewise in Goods one Yard wide, the Wheel Shuttle may be throw'd quicker through the Shed; and as a great Number of Weavers cannot throw their Shuttle through the Shed, without frequently striking against the Edges, which is one Reason for slack and bad edges, it is entirely avoided by the Use of the Wheel Shuttle.

2d, Another Advantage arising from the Use of the Wheel Shuttle is, the Weaving with the same is much easier than by the Hand Shuttle, and consequently more Work may be done in the same Time (with the Wheel Shuttle than with the Hand Shuttle) on that Account, and Children may sooner be set to the Loom, and accomplish their Work much better, than by the old Way; for it must be allowed, that as Men, Women, and Children, find themselves tired by their Labour, their Pace abateth; whereas in Labour that is not so tiresome, a Man may better and more chearfully continue the Pace he begun; likewise in all kinds of figur'd Goods where there are a great Number of Tradles, it's difficult to teach Boys to weave the Goods true, their Attention being so divided betwixt the catching of their Shuttle, and the treading of their Tradles, which Difficulty is removed by the Use of the Wheel Shuttle, as their Attention may be mostly confin'd to treading their Figure regularly over, by which Means they will make very few false treads, and young Boys in a very short time, be as capable of performing figur'd Work, as them of riper Years; likewise Persons disordered with Rheumatisms, &c., which has rendered them unable to weave with the Hand Shuttle, have readily and chearfully been enabled to accomplish their Work with the Wheel Shuttle.

3d, Another Advantage arising by the Use of the Wheel Shuttle is, that the Weft may be better laid in the Shed by the Wheel Shuttle, than by the Hand Shuttle, the Hand Shuttles Course through the Shed is Circlewise, the Wheel Shuttles Course being in a right Line, lays the Weft in the Shed in a shorter Course, by Means of which, a Piece of Goods may be wove with less Weft with the Wheel Shuttle, and at the same Time be neater and better, than by that wove with the Hand Shuttle; likewise in Weaving with the Wheel Shuttle, there is not that Necessity of putting the Lathe so far back, as in weaving with the Hand Shuttle, by which Time is saved. There are several Manufacturers in *Bolton*, who from long Experience, have found, and are ready to produce, Draw Boy Goods wove with the Wheel Shuttle with Ten Pounds of Weft, which shall be neater, and take as much or more Money in a Market, as Draw Boy Goods of the same Kind wove with the Hand Shuttle with eleven Pounds of Weft of equal Fineness with the ten Pounds before mentioned. Persons who weave very quick have a Spring to their Leathe, or give it a great Fall, so that the Leathe being pushed from them will fall against the Face of the Cloth, and most Persons who weave quick close their Weft as soon as they can pull out their Shuttle, at the Distance of five or six Inches from the Face of the Cloth, which with the Circular Course of the Hand Shuttle in the Shed, will easily account for the Loss of a great deal of Weft. Silk and Cotton Handkerchiefs look much richer with the same Silk in the Warp, and are neater with three Ounces less Weft in a Dozen of Handkerchiefs, if Foot and Hand go together, than if struck with a Cross Shed, and as the Wheel Shuttle brings the Weft so near the Face of the Cloth, any Kind of Goods may be struck with open Shed, or with Foot and Hand together, without losing any more Time, than if struck with a Cross Shed. And Experience makes it beyond all Doubt that neat light Goods of every Denomination, are much better, by being tread and struck at the same

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Time, as it lays in the Weft smooth, and leaves it without Ridges in the Work.

4th, Another Advantage arising by the Use of the Wheel Shuttle is, that the Weft comes off from the Spool, Pin, or Quill, nearly of the same tightness from End to End, and may be regulated to come off from the Spool, Pin, or Quill, nearly in what degree of tightness is necessary, for the Benefit of the Cloth and Strength of the Weft at the Weaver's Pleasure: Whereas in the Spool, Pin, or Quill, made Use of with the Hand Shuttle in the Old Way, the Effects are quite different, and excessively irregular; for Instance, when a full Spool, Pin, or Quill, is put into the Hand Shuttle in the Old Way, what with the Weight of the Spool, and the sudden Motion given it by the Weaver throwing the Shuttle into the Shed, the Weft is frequently broke, before the Spool can be put in right Motion, which if it escapes, the Danger is not less, when having passed through the Shed, the sudden Stop put to the Shuttle often causes the Spool to over-run itself, and which at the next throw frequently breaks the Weft, which supposing all happens to go well, and the Weft comes off to near the Bottom of the Spool, then the Stress upon the Weft must be a many Times more, in Proportion, to the Distance of Purchase from the Centre, betwixt a Spool when full, and when near empty, and which, consequently must either break the Weft, or impede the Shuttles Motion in the Shed; and Whereas it must be allow'd, that in all Weaving, it's requisite that the Weft be laid in the Shed in a proper tightness, from which if it deviates, it must be a Fault. It's easy to comprehend, that considering the Difference of Action, between a Spool (in the old Way) when full, as likewise when near empty, that it's impossible the Weft should be (by the old Way) laid in the Shed, any Thing like near what it should be, and which by the Spool, &c. used with the Wheel Shuttle, may be done a great deal better; the regular coming off of the Weft from the Spool used with the Wheel Shuttle, is a Reason why weaker Weft may be wove with the Wheel Shuttle, than with the Hand Shuttle in the old Way. From the Elasticity of Horse Hair, Tufts have been invented, as Springs are put into the Hand Shuttles to hinder the Spool from over-running itself, but have not answered what could have been wished for from them, as the Resistance from the Tufts must vary, as the Spools are full or empty; therefore to make the Resistance more equal, and somewhat like answer the Intention, the Spools must be very small, so that one of the Spools used with the Wheel Shuttle will be equal to eight of the other, which will cause a great Loss of Time in stopping, to supply the Hand Shuttle with Spools seven Times more than that of the Wheel Shuttle, if the Spools for the Hand Shuttle are made of the common Size, as five to one of the Wheel Shuttle the Resistance it meets with from the Tufts, endanger the Weft to break, or the Edge to be drawn in, and if that is carefully avoided, the Weaver must lose Time in Weaving the Upper Part of the Spool very slow; but by the Means of a moveable Eye placed in the Wheel Shuttle, that directs the Weft, it may be so regulated, that the Resistance the Weft meets with in coming off from the Spool (used in the Wheel Shuttle) will be nearly equal, during the emptying of a whole Spool. All Kinds of Irish or Scotch Yarn that is too hard twisted for Weft, may, by the Use of the Wheel Shuttle, be a little untwisted in the Weaving, and so ordered by Means of the moveable Eye in the Shuttle, as to be wove without any Snarls or Curlings in the Weft, and by the same Rule, all Sorts of Weft that are too soft, may be made a little harder, by having the Weft wound on the Spool the contrary Way, which, is easily done, by winding with the Wheel Band cross'd or open.

5th, Another Advantage arising from the Use of the Wheel Shuttle is, that in Weaving with the same, one Hand keeps its Position upon the Lathe Top, the other Hand holds an Handle, by which the Wheel Shuttle is cast through the Shed at Pleasure, which Lathe Top, and Handle, soon becomes warm, and keeps the Hands from being so soon numb'd in Cold Weather; Whereas by the use of the Hand Shuttle, the Weaver much sooner has his Hands numb'd with Cold, by changeably handling the Shuttle, first with one Hand, then the other, as by moving first one Hand, then the other, from the Shuttle to the Lathe Top, it so happens, that when a Weaver has his Hands numb'd with Cold, he frequently lets his Shuttle fall, by making false throws, by which, his Shuttle Points are damag'd, which breaks his Warp, and otherwise much hinders him, the Wheel Shuttle not being so liable to be thrown down, very much facilitates the Quickness of Weaving.

6th, As it appears that it is upon the Wheel Shuttle having the before-mentioned Advantages over the Hand Shuttle, that a Weaver may, in Cotton work of Half Ell wide, gain Fourteen pence with the Wheel Shuttle, as soon as One Shilling (in the same Kind of Goods) with the Hand Shuttle; so likewise it is to be observed, that when Goods are wove broader, the Wheel Shuttle has still a greater Advantage over the Hand Shuttle, so that in Goods wove Yard and Half, or two Yards wide, a Weaver may, with the Wheel Shuttle, weave as much in four Days, as in the same width with the Hand Shuttle in six Days; its likewise to be considered, that in broad Goods, the Weaving with the Hand Shuttle is very painful, and by continually leaning against the Breast Beam, frequently impairs the Persons Health, and is the Occasion of the Death of many; likewise the Weaver being of Necessity obliged continually to have his Arms extended, he cannot have such a powerful Hand or Foot upon his Loom, as is requisite he should have; whereas by the Use of the Wheel Shuttle, the Weaver sits at his Ease, with his Hand upon the Middle of the Lathe Top, and consequently with much more Ease, striketh to the Lathe, uniformly over the Piece; likewise neither Men nor Boys, except of a good Size, are able singly to weave broad Goods with the Hand Shuttle, whereas,

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by the Use of the Wheel Shuttle, Boys singly, may easily manage the Weaving of Broad Goods, and be much sooner set to the Loom, and in less Time Master of their Business.

7th, Now as it appears by the before-mention'd that the Wheel Shuttle is of great Advantage in weaving of Cotton Goods, both broad and narrow; and whereas great Quantities of Chequer'd and Strip'd Goods are Manufactur'd in this Kingdom, in the Weaving of which the Wheel Shuttle has not heretofore been applied to Advantage, by Reason of the Number and Changing of the Shuttles; and whereas a Method has lately been invented by *Robert Kay*, Son of *John Kay*, Inventor of the Wheel Shuttle, whereby Chequer'd and Strip'd Goods may be wove with the Wheel Shuttles, and be changed at the Will of the Weaver in a much smaller Time than in the common Method now practis'd, and in a Method capable to be understood by one of a slender Capacity. Now, he the said *Robert Kay* presumes, that by the above Invention, the same Advantages at least, which the Wheel Shuttle has over the Hand Shuttle, in weaving of broad and narrow Cotton Goods will likewise be in the weaving of Chequer'd and Strip'd Goods, which Advantages, for want of the above Invention, could not heretofore be had in the Weaving of Chequer'd and Strip'd Goods. Likewise the abovesaid *Robert Kay* has invented a Method, whereby two narrow Pieces of Chequer'd or plain Goods may, in the same easy and expeditious Manner, be wove by one Weaver, at one and the same Time, and the two Pieces better and more regularly selvaged, by which great Advantages may arise to the Publick; which invention of two Pieces of Goods to be wove by one Weaver at one and the same Time, cannot be applied to Advantage, in the weaving of Chequer'd and Strip'd goods, where the Goods are Strip'd in the Weft, but along with the Invention for changing the Shuttles; and as the Manufacturers in this Country are sensible of the Hardships of procuring a sufficient Number of Weavers to weave ten or eleven Nails and 3-4ths of a Yard wide Check, on account of the small Wages got on those Goods (especially in Time of War) by the above Invention of weaving narrow Chequer'd Pieces at once, the above Hardships will not only be removed, but the Weavers will be enabled to weave narrow Goods considerably Cheaper, and at the same Time get more Money, than they can at present in any Kind of Yard wide Check, by means of which the Manufactory will be on a much better footing then formerly, as the worst kind of Goods may be manufactur'd with equal Pleasure as the best Kind, it must have been a great Grievance to the Manufacturers, they having made great Quantities of some Kinds of Goods for which they had no immediate Demand, only to keep their Weavers in good Humour; and as the before-mention'd Invention of Weaving two narrow Pieces of Goods at once, will be of great Advantage in Fustians and other Kinds of Plain narrow Goods, as in Chequer'd and Strip'd Goods, by means of which the Weaver will not only get more Money, and at the same Time weave them Cheaper than heretofore, by which they may be brought cheaper to foreign Markets, which must not only increase the Demand but secure the Trade to ourselves, and give us the Advantage over Foreigners. Likewise the before-mentioned *Robert Kay* has by a Construction of the Wheel Shuttle of Iron, caused the same to be more beneficial than those made of Wood, because the Wheel Shuttle made of Iron will contain a larger Spool than that made of Wood, notwithstanding the length of them be both a like, and the Wheel Shuttle may be made of Iron to any necessary Degree of smallness, and at the same Time run more steady than those made of Wood, by having the Rims of the bottom Wheels further asunder, by which it runs on a larger space; those Wheel Shuttles of Wood cannot be made very small, and at the same Time have a sufficient Weight and Strength, the Iron Wheel Shuttles may be made to any necessary Weight, by which a Weaver may cause its Course through a bad Shed to be more sure, and as it must very much facilitate the quickness of weaving, by always having their Shuttles in good order, those made of Iron will continue very near their original Perfection many Years longer than those made of Wood, those made of Wood, being subject by the alteration of Moisture and Drought, to crack and twist the Shuttle Body which sets the Wheels out of their true Direction, and causes the Shuttle not to run so well, and is an hindrance to the Weaver, which is not the Case with those Shuttles whose Bodies are made of Iron: the Iron Wheel Shuttles will not only be much more advantageous in the weaving of narrow Goods but likewise of very great Advantage in broad heavy Goods, especially in the weaving of Bed Ticks, by Means of which, Bed Ticks may be wove better, and much easier, than in any Method heretofore practised.

As there is no doubt but it will greatly surprise any one who reads the before-mention'd, to think that if the Wheel Shuttle has the Advantages over the Hand Shuttle as is herein set forth, how it comes to pass the Wheel Shuttle has made so small a Progress, in a Country where Trade and Manufactures are of such Importance to every one, from the King down to the Beggar. In Answer, Mr. *John Kay* having invented the Wheel Shuttle, obtained a Patent for the same, thinking thereby to secure to himself in the vending or hiring out the Wheel Shuttles, some Advantage which might serve as a recompence for the Invention, and having set several of the Wheel Shuttles to Work, on broad Woollen Goods, it appeared that one Man would do as much Work, and better with the Wheel Shuttle, as two Men with the Hand Shuttle, upon which the Weavers concluded, that in Consequence as one Man could by the use of the Wheel Shuttle do as much Work, as two Men with the Hand Shuttle, one half the Weavers then employed in the broad Woollen Way must (if the Wheel Shuttle went forward) starve for want of Employment. The Weavers therefore assembled in a Mob, determining to hinder the Wheel Shuttles

Progress, by killing of Mr. *John Kay*, the Inventor, who very narrowly escaped by flight; the Mob went to the Houses where some of the Wheel Shuttles were at Work, and forcibly seized and burned them, and otherwise ill-used the Houses, yet notwithstanding the threats of the Mob, &c. several Manufacturers who lived at a Distance from the Places where the Mobs assembled, being sensible of the Benefit which would arise to them, if they could Manufacture their Goods upon easier Terms than their Neighbours, got the Wheel Shuttles fixed upon Looms in their own Houses; the Weavers on which for the most Part, did all in their Power (by loitering away their Time, and spoiling their Work) to keep their Masters ignorant of the Advantages which attended the Wheel Shuttle; for its to be observed that the Weavers who were good Workmen, and the Weavers who were bad Workmen, where equally bent against the Wheel Shuttle, for the following Reasons. The Weavers who were good Workmen, were afraid, that if the Wheel Shuttle went forward they would stand little better Chance than the Weavers who were bad Workmen, as the facility of the Wheel Shuttle would put them nearer on a par as Workmen, and consequently they would lose their Priviledge, of either having more Wages or in bad Times being constantly employed; on the other Hand, the Weavers who were bad Workmen imagin'd that if the Wheel Shuttle went forward, there would not be Employment for so many Weavers in the broad Woollen Way by one Half, and they conscious of their own Abilities, imagin'd that it must be their Lot to be unemploy'd; but as what is here said is not meant of the whole Body of Weavers, so likewise there were several, who well considering their own Interest, got the Wheel Shuttle, by which they got almost double to what they could by the Hand Shuttle, yet gave the Wheel Shuttle a bad Character, for fear, its general Use might prove to their Disadvantage; yet notwithstanding which, the Advantages of the Wheel Shuttle were so evident, that it every Day gained Ground, and the Inventor Mr. *John Kay*, expended large Sums in furnishing the Weavers with Wheel Shuttles, at the rate of fifteen Shillings a Year, which Rent when due, being demanded, most Part refus'd Payment, which caused Mr. *John Kay* to have recourse to the Law for recovery of his Rights, and was withstood by several of the Weavers, who were supported by Contributions from others, and as Mr. *John Kay* could not with Convenience be engaged in Law with all from whom Money was due, and who denied him Payment, it so happened, that a great many who did not contribute in Money against him, yet, thought proper not to Pay, choosing rather to wait the issue of a Number of Law Suits (well knowing that might overcomes Right) which the Defendants so prolonged that Mr. *John Kay* had spent his all without being able to bring his Affairs to issue, which bad usage caused Mr. *John Kay* to stop giving necessary Directions for setting the Wheel Shuttle to Work, as likewise from communicating any Improvements which generally occur when an Invention comes to be put into Practice. Another Thing which must hinder the Wheel Shuttles Progress was, that when attempted to be set to Work, the Weavers have frequently thrown it up, and fallen to the old Way (whereas a few Words of Instruction would have enabled them to have gone forward very easily) they imagining the fault was in the Wheel Shuttle and not themselves, gave the Wheel Shuttle a bad Character, which has hindered many from attempting it, but as has been before mentioned, Mr. *John Kay* being engaged in several Chancery Suits for the recovery of his Rights, which Suits were so prolonged, that with the Charges thereof, and supplying the Weavers with Shuttles, his all was expended, at which Time he made his case known to several Members of Parliament, thinking either to get a Premium and let his Invention go free, or an Act which would enable him to come at his Rights otherwise than by tedious Chancery Suits, and having waited some Time in Expectations, at length was quite wearied out with Attendance and Dependance, and therefore resolved to apply to the *French*, who upon his arrival at *Paris* ordered him to *Amlui* in *Normandie*, where the Wheel Shuttle was experimented, which gave such Satisfaction, that upon Mr. *John Kay's* coming back to *Paris*, the *French* Ministry made him a Present of fifteen thousand Livres, and the Province of *Languedoc* seven thousand Livres, and granted him a Patent for the sole making and vending of the Wheel Shuttles throughout *France*, the Province of *Languedoc* excepted, likewise a Pension of two thousand five hundred Livres Yearly, for his Life and his Son's Life after him, as likewise to be rewarded for any other Invention as it might Merit. Mr. *John Kay* has invented several Things very beneficial for Trade, which he has not yet made publick to the *French*, occasion'd by the *French* being at this Time so distress'd for Money to carry on the War, that they have stopped Payment of all Pensions and Gratuities regarding to Trade, untill Peace be made.

FINIS.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 6th, 1911; LORD REAY, G.C.S.I., G.C.I.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Child, Henry William Robert, Briardale, 33, Crediton-road, West Hampstead, N.W.

Loch, Lieutenant Percy Gordon, I.A., c/o Messrs. Cox & Co., Hornby-road, Bombay, India.

Newlands, Lord, LL.D., 36, Grosvenor-square, W., and Mauldslie Castle, Carluke, N.B.

Prankerd, Miss Edith, 51, Campden Hill-court, Kensington, W.

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The following candidates were balloted for and duly elected members of the Society:—

Bates, Sir Percy Elly, Bart., Hinderton Hall, Neston, Cheshire.

Johnston, Francis Alexander, 16, Draycott-place, Chelsea, S.W.

Price, Herbert, J.P., Berry-street, Queenstown, Cape Colony, South Africa.

Roy, Charles S., Ph.D., 35, Mary-road, Stechford, Birmingham.

Singleton, Miss Esther, 854, Seventh-avenue, New York City, U.S.A.

Thomas, Cecil, 1, Great Pulteney-street, W.

Walton, Robert, 14, Rue Dieu, Paris, France.

The Chairman, in introducing the reader of the paper, said the history of no colony had probably been the object of deeper research than that of British Guiana. Composed of three provinces, all originally colonies founded by the Dutch—Essequibo, Demerara, and Berbice—it came into the definite possession of the British in 1814; an attempt to settle its boundaries was made in the forties by one of the most painstaking explorers Great Britain ever employed, Sir Robert Schomburgk, but the results of his work lay dormant for nearly half a century. The discovery of gold in 1887, and the encroachments of Brazil on the one hand and of Venezuela on the other, rendered it important that the boundary should be fixed, and Great Britain accepted arbitration early in 1896. A band of men was called together, each an expert, to collect evidence both in the colony and in the leading archives of Europe. Sir Everard im Thurn, for instance, who was present at the meeting, who had lived in the colony for many years, and who was better acquainted with the native Indians than any other white man, contributed largely from his local knowledge. The evidence dug out of archives was subjected to the learning of linguists, and in that way the vast mass of Dutch documents which came into the possession of this country with the colony was turned over to Mr. de Villiers for perusal, selection, and translation. In those documents Mr. de Villiers found not only material rich in historical interest and of legal importance, but data concerning the life of an utterly forgotten Governor who was worthy of a place in the Netherlands Valhalla, and who laid the foundations of colonies that were later to form part of the British Empire. It was the life of that man which Mr. de Villiers now proposed to place concisely before the meeting. Though the work of preparing the evidence laid before the two boundary arbitrations, that went on practically from 1896 to 1904, fell upon the band of experts he had mentioned, under the leadership of Mr. Charles Harris, of the Colonial Office, the conduct of each case fell upon the Attorney-General then in office; in the earlier of the two, that of Venezuela, the Attorney-General was Sir Richard Webster, now Lord Alverstone, and a letter had been received from his lordship expressing his regret at his inability, due to a long-standing engagement, to be present at the meeting. Lord Alverstone was the senior counsel in the British arbitration with Venezuela, and spoke for thirteen days before the Tribunal that met in Paris in 1899, and which resulted in the fixing of the boundary. Sir Everard im Thurn was also a member of the Commission, and was long resident, and a great explorer, in British Guiana; and after the paper had been read he was sure those present would be very glad to hear what he had to say on the subject.

The paper read was—

BRITISH GUIANA AND ITS FOUNDER —STORM VAN 'S GRAVESANDE.

By J. A. J. de Villiers,
Hon. Secretary of the Hakluyt Society.

The coast of Guiana was first sighted, by Spaniards, as early as 1500, though no permanent landing was effected by them until 1591, when their exploration of the Orinoco led to the establishment of the hamlet of San Thomé on that river; for more than a century, however, there was no other Spanish settlement south of it.

In the year 1596 Sir Walter Raleigh published his work entitled "The Discoverie of the Large, Rich and Bewtiful Empire of Guiana, with a relation of the great and golden city of Manoa, which the Spaniards call El Dorado."

In the year following that in which Raleigh's book was issued, and prompted most evidently by that publication, there set out for a voyage along the Guiana coast a Dutch merchant named Anton Cabeliau, who, on his return to the Netherlands in 1599, wrote so alluring an account of the wealth and trading advantages of the country—though in more sober and veracious vein than Raleigh—that a petition was almost immediately presented to the States-General for permission and aid to send colonists thither. No official sanction for this venture was forthcoming until it was embodied in the charter granted to the Dutch West India Company on its creation in 1621, but there is some evidence of private enterprise in the River Essequibo at least five years before that date. In 1625 the settlement began to be exploited by that branch of the aforesaid Company which had its seat in Middelburg, the capital of the province of Zeeland, and we can thenceforward follow its internal development by authentic and well-defined references to its trade and its officers.

In 1649 the Dutch suffered the great reverse which broke their power in Brazil. That country,

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like other Dutch possessions in America, had been run by the West India Company, and by 1657, thirty-two years after its official occupation of the Essequibo River, the said body had grown weary, too, of the heavy charge of its Guiana colony, and transferred that charge to the three towns of Middelburg, Flushing, and Veere.

It is not at all strange to see these three towns —comparatively insignificant though they are to-day—embarking in 1657 upon ambitious schemes of colonisation. The middle of the seventeenth century found the United Netherlands at the very summit of their greatness—"they stood in 1648 without a rival as the first of maritime and commercial powers"—and in the three towns of Middelburg, Flushing and Veere were collected the merchants and the riches of the powerful province of Zeeland, whose Chamber represented two-ninths of the shareholders of the West India Company. That Company had been established in 1621, less with a view to steady trade and colonisation than in the hope of conquering rich lands or wresting booty from Portugal and Spain, and the determination to get rid of its comparatively unimportant Guiana colony was possibly not so much due to the loss entailed by the abandonment of Brazil in 1654 as to the attention—out of all proportion to any profits—which Essequibo required; the Company could not yet have forgotten that seven years after its own establishment Admiral Piet Heyn had with one stroke seized for it a Spanish treasure fleet (valued at one million pounds sterling) that enabled it to pay a dividend of 50 per cent.

In 1670, after an administration of only thirteen years, the three towns handed back the Guiana colony to the West India Company, but the Zeeland Chamber of that body always continued to enjoy predominant rights over the colony's trade and shipping, to the envy of the other Dutch provinces.

The beginning of the eighteenth century marks the furthest extension of the sphere of Dutch influence which had its base in Essequibo. At that date the colony was governed from Fort Kijkoveral, which stood on an island near the confluence of the Essequibo with two of its main branches; on the banks of these three streams were some plantations of the Company and others belonging to private individuals. To the eastward there was no settlement nearer than Berbice, which was formed in 1628, and the Demerara River was unopened. Westward, the sphere of the Dutch extended along the coast to the mouth of the Orinoco, and in the interior also to the neighbourhood of that river. Southward, up the main river of Essequibo, there was at that time no station, but the Company's traders were quite accustomed to journey up its tributary, the Rupununi, then to proceed across country to the savannahs which lie between Guiana and the Amazon, and probably even further to the south.

In 1704 was born Laurens Storm van 's Gravesande, the man to whom the government of the colony was entrusted from 1738 to 1772, a man so utterly forgotten even in his own country in the nineteenth century, that the late General Netscher, a Dutchman, in his "History of the Colonies of Essequibo, Demerara and Berbice"—an invaluable work to all interested in British Guiana—speaks of him as one of those meritorious Netherlanders "whose names are but little or not at all known and who nevertheless deserve to be dragged from oblivion."

Storm's life covers a very important if comparatively brief period in the colony's history. Though it cannot be claimed that there was, under his governorship, any extension of the boundaries of the vast country entrusted to his jurisdiction, yet under Storm Essequibo reached the apex of its prosperity whilst subject to Dutch rule, under him Demerara was actually commenced; by his untiring energy the desert places were peopled, by his tactical ingenuity the savage tribes were subjected, by his patriotic zeal his envious and bellicose neighbours were kept off. If not extension there was certainly consolidation.

This man, whose despatches mirror for the third of a century the history of Essequibo and Demerara, was, as we shall see, one of no mean type, and yet of a stamp common enough in the Netherlands of his time. That commonwealth, exhausted by long, ruinous and bloody wars, was, at the beginning of the eighteenth century, rapidly sinking in status as a great European power, and the men in whose veins flowed the blood of the "Beggars" would naturally lose patience in petty home politics, itching to conquer new lands and races, as their fathers had done in their country's more glorious past.

Storm van 's Gravesande came of an old family which had sat, from father to son, in the councils of Delft from the year 1270. Just a century before the birth of the future Governor, Laurens, his great-grandfather and namesake, was born in that town in 1605, but became early domiciled in Bois-le-Duc, where he filled several municipal

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offices from 1640 to 1685; Dirk, Laurens' third son, born in 1646, followed his father in these and in more important posts, and out of Dirk's family of ten children, three—the father and two uncles of our hero—require mention here.

Pieter was born in 1683; he filled offices similar to those held by his father, Dirk, and died in 1721. His eldest son was Laurens, the Governor, whose life we follow to-night.

Dirk's second son was Ewout Hendrik, uncle of our hero; he succeeded to at least one of the offices held by his father, and married in 1722 a Baroness Boyd of Kilmarnock, daughter of James, captain of a Scottish company in the service of the Netherlands.

The third was Willem Jacob, another uncle of our hero; he dropped the surname of Storm, and acted in 1715 as secretary to an embassy sent by the States-General to congratulate George I. on his accession to the throne of Great Britain. His brilliancy as a mathematician gained him the friendship of many eminent Englishmen (among these being Bishop Burnet and Sir Isaac Newton), whilst the Royal Society enrolled him as one of its members. He became professor of astronomy and mathematics at Leiden University in his twenty-ninth year, and subsequently occupied the chairs of civil and military architecture and of philosophy, refusing invitations to join the Russian and Prussian Academies that came to him from Peter the Great and Frederick the Great respectively. Voltaire, who made his personal acquaintance, spoke of him as "*le profond 's Gravesande.*"

Such were the forbears and kinsmen of the man who was destined to play a prominent part in the western portion of his country's empire, in domains which, though sparsely peopled, were so rich in possibility that they attracted both the envy of the haughty Spaniard and the industry of the plodding Brit, and the influence —often a very pressing one—of these two nationalities bears largely on the Governor's life.

Born at Bois-le-Duc on October 12th, 1704, Storm van 's Gravesande entered the army in his seventeenth year, a somewhat hot-tempered youth, perhaps, for in his despatches he frequently mentions his habitual outspokenness, and late in life speaks of a quarrel he had in 1730 with his stepmother's father, the Burgomaster of Utrecht, in the following words:—

"Having always acted in keeping with the traditional Dutch outspokenness, having always, during my full seventeen years of military service, gone straightforwardly to work, and never been afraid to tell my chiefs the truth outright and, though with due respect, without circumlocution, I thereby gained their esteem, and have still by me the letter wherein my old colonel, General van Pallandt, then eighty-two years of age, did me the honour to write (upon my informing His Excellency of my intention to go to Essequibo, and thanking him for all the benefits conferred on me), that he was very pleased indeed to hear of my advancement, but that he was at the same time sorry to lose one of his best officers. His late Serene Highness, of laudable memory"—that was William IV., Prince of Orange, the Hereditary Stadtholder—"having been good enough to take the trouble to read all my letters to YY. HH., also did me the honour to say"—this must have been in 1751, when Storm was on a visit in Holland—"'You are still the old Storm van 's Gravesande—"Straightforward John"' (alluding to the affair concerning H.S.H. which I had had twenty years before with my stepmother's father, the Burgomaster of Utrecht, where H.S.H. was then studying, and which cost me my promotion), adding, 'had you stayed here you would now be one of our generals.'"

So, quitting the army, Storm elected to serve the West India Company in their colony of Essequibo, as secretary and book-keeper, and took the oath in Middelburg in October, 1737. Henceforward he was to show obedience to a body of directors who left him (sometimes for years) without the means of carrying out their instructions—to exact obedience from underfed, unwilling slaves, from selfish and disloyal colonists.

Prizing and pocketing his colonel's hearty congratulations upon his advancement, the young soldier sets out with wife and five children for his new home; and, though he doffed the soldier's coat, Storm was before all, and throughout all, a soldier. The very first subject he deals with in his first letter home is neither sugar nor shipping—the two that interested the directors most and were to give him so much trouble later—but the condition of the militia. From the men to the forts the transition was a natural one, and Storm, with that patriotic zeal and lack of mercenary motive that characterised all his actions, promptly offers to superintend the construction of a new fort, as a relaxation, perhaps, from his more sedentary secretarial duties, which, though probably irksome, were well and conscientiously discharged.

The completion of the fort in a comparatively short time, considering the difficulty experienced in procuring labour and material, gave both Storm and the colonists great satisfaction, but the militia continued to be a sore trouble to him to the very end. Without an efficient force it was impossible even to keep the slaves in awe,

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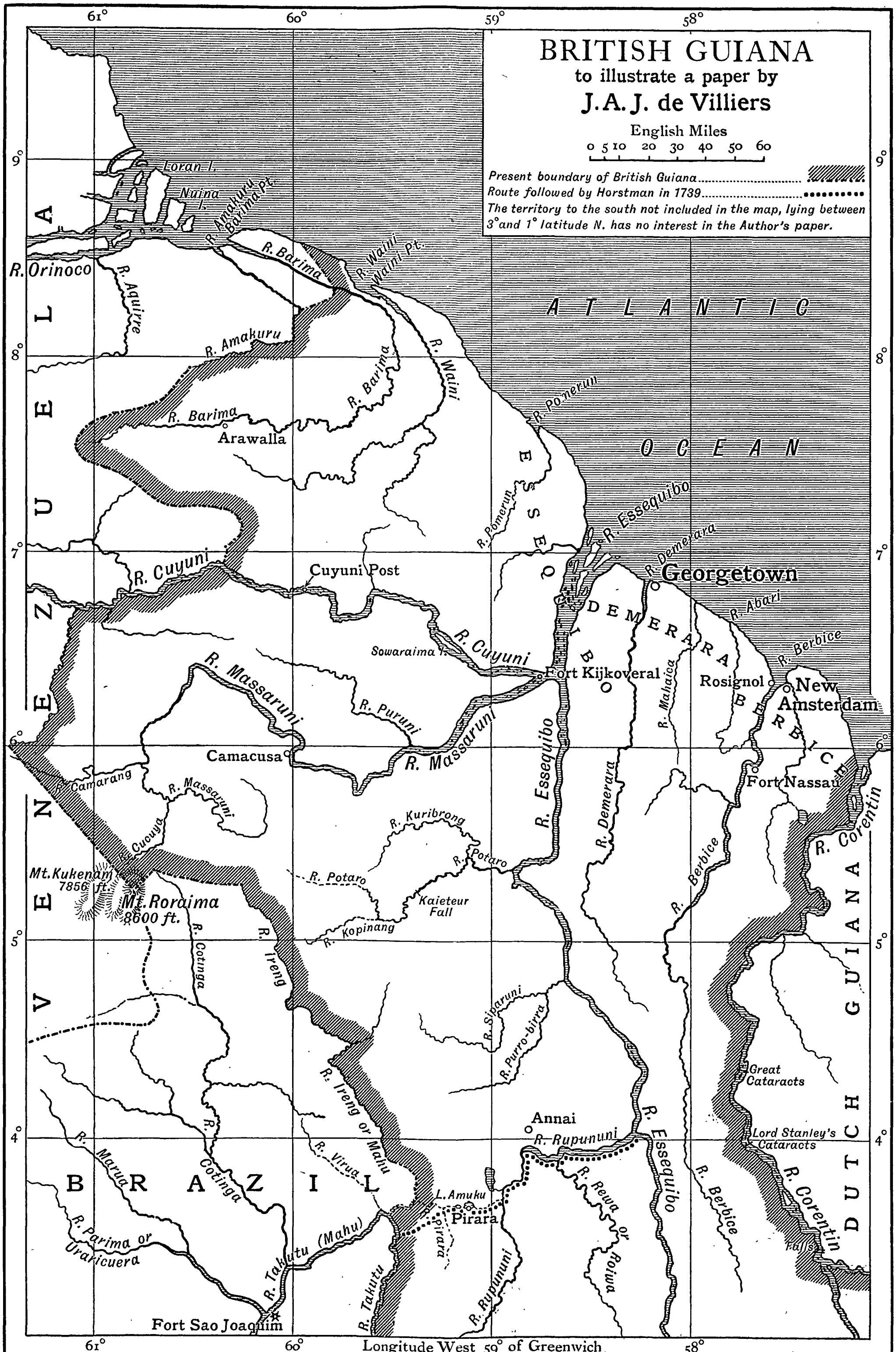

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Emery Walker sc.

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let alone to repel Spanish encroachments, and year after year we find Storm urging upon the directors with wearisome reiteration the necessity of sending out reinforcements of honest, well-trained men.

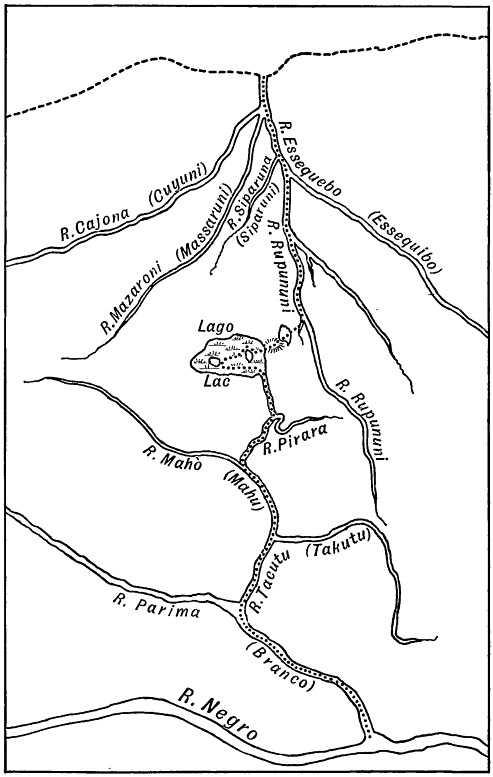
The Commander died in July, 1742, and the Councillors, appreciating the extraordinary zeal and activity displayed by the secretary, provisionally appointed him Commander whilst awaiting orders from home; the appointment was made a definite one in Zeeland on April 13th, 1743.

From that time onwards Storm's despatches teem with interest; the whole of them, covering a period of thirty-four years—from 1738 to 1772—would fill twenty-one volumes of three hundred octavo pages each. With conscientious care and in laborious detail Storm wrote from day to day on the ordinary occurrences of the colony's life. The ships that come and go from Zeeland, the cargoes that they bring, the supplies that he needs, the produce sent home, the gains by trade, the losses in certain ventures, the state of the Company's plantations, the doings of the Company's servants, of the dominie and the doctor, questions of police, matters of civil jurisdiction, the squabbles of individuals—detail upon detail that go to make up the life of a settlement—all these are found in the Governor's despatches. Basing my remarks entirely upon the contents of these despatches, which came into our possession with the colony in 1814, it is my purpose to-night to summarise broadly Storm's main policy in those matters which affected the development of the colony, and to sketch briefly, mostly in his own words, Storm the Man.

As I have already said, the territorial consolidation of Essequibo constitutes the chief feature of Storm's governorship, and in three separate ways this is disclosed in his despatches—first, in a definite policy of development and exploration; secondly, in the policy pursued towards the various Indian tribes on the coast and in the interior; thirdly, in the discussion concerning the frontiers, and Storm's stout defence of the rights of the Netherlands against Spain.

Of Storm's masterly policy of exploration I will give but one instance, though a very important one, for it finds a place in the historical geography of the world. Only a year after Storm's arrival in the colony, one Nicholas Horstman, a German surgeon in the employ of the West India Company, was sent up the Essequibo to find a passage to the Amazon River, to trade with the natives *en route*, and *en passant* to discover, if possible, Raleigh's famous but mythical city of El Dorado, situated on the equally mythical Lake Parima, a lake that was portrayed as of enormous extent on all the maps of South America till then published.

Crossing the watershed between the Essequibo and the Amazon, Horstman found the true origin of the Golden Lake, just as Robert Schomburgk rediscovered it one hundred years later. It was only a small lake—Lake Amucu—which occasionally overflowed its shores and formed a great swamp. On reaching the Rio Negro, Horstman,



Horstman's Map
from the Original in the Bibliothèque Nationale
(His route is shown thus:-..................)

either by force or by inclination (it is not clear which) remained with the Portuguese. There he met La Condamine, and handed that traveller a map of the country he had traversed, the first showing the true configuration of the land between the Essequibo and the Amazon. La Condamine handed it to d'Anville, a famous map-maker of the eighteenth century, and by him it was made the basis of a generally correct delineation of that part of the country in the first great map of South America, published in 1748. Humboldt often refers to Horstman's map

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in his "Voyage aux Régions équinoxiales." It was lost for about a century, and was finally unearthed in the Bibliothèque Nationale in Paris some ten years ago, when it proved of immense value in our arbitration with Brazil, as showing the extent of the Dutch sphere of influence already at that time. And it was, of course, from the Dutch that the British inherited their claim.

Storm's policy with regard to the natives generally was a broad and enlightened one; so far as it was actuated by self-interest it certainly recognised that self-interest was bound up in the general interest of the Indian tribes. It was an advanced policy for that age. Summed up briefly, it was embodied in the following sentences from a despatch of 1769:—

"There is no one, Your Honours," says Storm, "who is more convinced how advantageous and necessary the friendship of the Indians is to this colony, because so long as we are fortunate enough to have them living around us, we are quite safe inland, and have nothing to fear concerning the desertion of our slaves"—the slaves were negroes imported from the west coast of Africa, and no South American Indian was allowed to be used as such. "I therefore neglect no possible opportunity of cultivating the friendship of the same and of protecting them from all the ill-treatment and tyranny of the whites as far as it is expedient to do, and in this way I have made myself so beloved by them, that I can now get them to do whatever I wish."

The results of the policy just described remained down to our own times. The Indians paid the British in the next century the same allegiance they had given to the Dutch, and the protection and privileges which were the natural return for such allegiance were readily accorded.

We now come to the diplomatic side of Storm's administration, and it is, perhaps, the most interesting and important of any. I have already mentioned that since their settlement on the Orinoco in 1591, the Spaniards made no progress to the south of that river for more than a century, and it was indeed a hundred and fifty years before their presence was felt within the Dutch sphere of influence.

It was in 1746 that tidings were first brought to Storm by one of the far-travelling traders that the Spaniards had built a mission and a small fort on the Cuyuni. He at once wrote home:—

"I feel not the least diffidence as to dislodging them from that place and capturing the fort, but such a step being one of great consequence, I dare not take anything upon myself, especially as the proper frontier line there is unknown to me."

There was, of course, no proper frontier line, and the West India Company merely evaded the question and left to Storm the responsibility of solving the problem and keeping off the Spaniards. Having no soldiers but a few unreliable French and Germans, the Governor had recourse to diplomacy of two kinds—playing off the Indians against the Spaniards, and inditing remonstrances that were to be laid before the States-General and referred by that body to the Court of Madrid. In 1748 Storm writes home:—

"Seeing that all my remonstrances and letters to the Spaniards are of no avail, and no redress is obtainable, I intend to tell the chiefs of the Indians when they come to me that I can provide no redress for them, and that they must take measures for their own security. Then I feel assured that in a short time no Spaniard will be visible any more in the upper Cuyuni. However, before we come to that, I will next month once more send a letter to the Spanish Governor of the Orinoco, and explain this matter to him seriously, with all courtesy, as well as the consequences, which cannot but be disastrous for them, and then await his reply, in order to govern myself thereby."

That Storm's distrust of the Spanish was very largely justified has, in late years, been proved by the discovery of documents showing that there was in 1754 a secret agreement between Spain and Portugal to make an effort, without open declaration of war, to squeeze out the Dutch from their possessions in America. Often the Governor's military ardour and patriotism would almost outrun his discretion. "If," he writes home again and again when Spanish raids had been made on undoubtedly Dutch territory, "if I were permitted to do as they are doing, I would risk my grey head once more, and make them pay doubly for the annoyance they are causing us."

But the Dutch West India Company moved with caution, and sent Storm neither encouragement for reprisal—nor soldiers. They had evidently greater faith—and in this they were for once right—in the efficacy of Storm's official despatches that I have already alluded to; these, in some measure revised and given diplomatic form, were in 1759 and again in 1769 the basis of official remonstrances to Madrid, which eventually stopped overt acts of aggression whilst Spain held the country, now Venezuela, to the north-west of the Dutch colony.

Storm's anxiety to maintain the boundaries and rights of the Dutch, and his firm stand against the aggressions of the Spaniards, were at once the foundation and the coping-stone of his efforts to consolidate the colony as a geographical unit. Just as his trading ventures and his

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Indian policy fixed the geographical extension of the colony of British Guiana, so his vigorous denunciation of Spanish claims and his diplomatic measures to repel their encroachments furnish the legal basis upon which the British found their title to their one South American colony. When, 150 years after his time, the question of that colony's area came to be fought out before an international tribunal, it was Storm's work and utterances which gave such welcome support to the successors of the Dutch. Storm's governorship must, therefore, always have a living interest for the British as the period which made the present colony of British Guiana a possibility, and the history of that country can never be divorced from Storm's work.

In the early years of his administration Storm's regular despatches home were by no means so voluminous as later, but there is scarcely a letter written by the Commander that does not give the reader a closer acquaintance with the man. A soldier, his constant striving was after peace—peace within and upon his borders—and to him peace and concord were synonymous with the fear of God. The "restless spirits" that already early rendered his efforts fruitless were probably the "godless calumniators" of whom he complained so bitterly in 1745. These had evidently gained the ear of the directors in Zeeland, whose unworthy treatment of the Commander, added to their almost criminal neglect of the colony in the matter of supplies, soon rendered Storm's service bitter to him, for already in December, 1746, he applies for his discharge in most apologetic terms, the application being repeated eight months later.

How the directors replied to this is shown in a letter of Storm's dated February, 1748:—

"In the first place and before all else I find myself in duty bound to thank YY. HH. from the bottom of my heart as well for my son's promotion and the increase in my own salary as for the present of the negro with wife and child. These manifold proofs of favour, although material ones of great importance to me, and calling for deep gratitude, do not however afford me so much real satisfaction and pleasure as that which I derive from Your Honours' kind declaration that YY. HH. are pleased to approve of my services and that these proofs of favour shown me are to be regarded but as an earnest of that approval. This always having been my heart's desire and that wherein all my honour was centred imposes upon me such obligations that the power rather than the wish will fail me to fulfil them, but be assured, YY. HH., that so long as it shall please the Almighty to grant me health and strength it will be my sole endeavour and aim to further the interests of the Honble. Co. and the welfare of this Colony with all possible zeal, sparing neither trouble nor assiduity to attain that worthy object."

Though the foregoing expressions of loyalty and gratitude may appear rather fulsome, that they were not unmeaning is proved by the fact that, in spite of neglect on the part of the directors at home and in the face of tremendous difficulties, Storm held the command for a quarter of a century after. The increase in his salary was from 500 to 800 guilders, but, as he reminds the directors many years later, it was unasked for.

In March, 1749, Storm became "convinced that it would be very advantageous" to give his masters "a full verbal report" of the condition of the colony, and therefore applied for leave to visit Europe. The leave was granted, but the visit was ill-advised. Storm's absence of two years from a colony seething with godlessness and disloyalty proved too great a strain for the maintenance of what slender authority he possessed; the Commander, well received at home by the ruler, Prince William IV., and other magnates, was raised to the dignity of Director-General, and his eldest son was given the commandership of the newly-founded settlement of Demerara; the Company, however, seized the opportunity of insisting upon what is referred to as their "great reform," a system of false economy first mooted in 1744, which Storm then and frequently thereafter roundly denounced as fatal to the colony—as, indeed, it proved.

Taking what he knew to be a last farewell of all his friends in the Netherlands, since he had no interests there ever to call him back, Storm returned to Essequibo to find his authority greatly impaired, the planters regarding the head of the colony (more than ever since his visit home) as the mouthpiece of a Company which neglected their interests and sought only its own profit. Storm had henceforth a treble battle to fight—discontent within, invasion by the Spaniards ever imminent (or what was nearly as bad, a fear of it), and neglect, born of dissatisfaction, on the part of the home authorities. It was an unfortunate *cercle vicieux* —neglect at home responsible for the colony's backwardness and *vice versa.*

To Storm's official cares during this period were added domestic afflictions that weighed heavily upon him. On the last day of 1752 he lost his second son, and eight years later, within

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fourteen months of each other, followed the deaths of his wife and eldest son.

The sole distraction from his troubles Storm found in the pleasure he derived from the rise of Demerara. Only a few months after his return from the Netherlands in 1752, he writes most optimistically of the progress being made by the young colony commenced under his auspices in 1746, mentioning both the activity of one Gedney Clarke, of Barbados, and the coming of other English planters from other isles.

Storm was neither Anglophile nor Anglophobe; he always spoke of the English as he found them, whilst the variance in attitude which he adopted or advocated in dealing with them was dictated not by personal caprice, or feeling, but by the varying interests of a Company whose welfare he conscientiously guarded above all else. Very soon after his appointment as Commander, he wrote home:—

"The English who have already established themselves here spare neither trouble, industry nor cost, and most of the planters are already beginning to follow their example."

General Netscher, in the work I have already mentioned, ascribes, in most emphatic language, the subsequent cession to Great Britain of the colonies of Essequibo and Demerara to this immigration of English planters, though he fully exonerates the Governor from all blame in not foreseeing this result. "When," he says, "Storm encouraged the English to settle in Essequibo and Demerara, he was undoubtedly acting wisely, for they brought with them energy and gold, both of which the colony lacked."

In the very next letter to that in which he announced Clarke's enterprise, Storm speaks of him as "a man of judgment and of large means, having the welfare of this colony really at heart." And Clarke, by his subsequent conduct, fully justified Storm's opinion of him on both these points; for, when in 1763 Demerara was threatened with a slave rising similar to that which had just ruined the neighbouring colony of Berbice, it was Clarke's activity and aid that led Storm in his letters home to admit, and more than once, that the succour sent by the English "was, after God, the salvation of Demerara."

If fault there was in allowing both planters and slaves to see the weakness of the power that ruled them, that fault lay surely not with the man who, already laden with petty administrative cares, used, in an emergency, the means nearest at hand to protect his charge, but with the Company whose almost criminal neglect drove him to such an extremity. I have shown how Storm pleaded in vain from first to last for an efficient garrison; we have extant his constantly repeated and equally vain cry for supplies. It would, however, be thought that news of a slave rising would have aroused the sleepy directors out of their lethargy. Storm advised them of the revolt in March, 1763, but at the end of September had to write:—

"The discontent is getting so great and general, that I fear for the consequences. The aid sent is so small in proportion to the immensity of the danger."

And yet, whilst Storm was compelled to lay copies of his letters home before the colonists to convince them that he at least had done his duty, the directors in Zeeland, having sent the inadequate aid just mentioned, supplemented it by a despatch wherein they "imagine the danger will have passed over before the receipt of the same." "Far is it from being so," replied Storm; "the danger is as great as, if not greater than, it ever was."

However, in the end the danger was exorcised, at what, indeed, seemed enormous cost, and Storm and the colony emerged from the crisis both a little the worse for the stress.

The shadow of the calamity which had come so near in 1763 was still upon the Governor when, in the spring of the following year, he wrote announcing the death of his son-in-law (who had been made Commander of Demerara after the death of Storm's own son, and who was his right hand in the administration):—

"My years, my poor health, sorrow, vexations, and constant opposition, in addition to the burden which is now about to fall entirely upon me, without the least help, make me weary of my office, of the country, yea, even of life itself."

The failure on the part of the Company to send out slaves or supplies was undoubtedly his chief trouble; sensitiveness to petty calumny, another; domestic afflictions a third. It is, therefore, not surprising to find the Governor once more repeating in 1766 the application for his discharge, already made with great insistence, but in vain, in 1763. The constituent bodies of the West India Company were, however, in the throes of a long dispute concerning freedom of trade with the colony, and gave little thought to relieving or releasing their old servant until a moment more opportune to themselves.

In July, 1771, Storm writes:—

"It is now eighteen months ago since we received the last goods for the slaves."

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In September of the same year he says:—

"There is not a nail left to fasten anything with or to nail up the sugar casks. We are without a thing."

And again, in November, he writes:—

"Lack of provisions has never been greater. On ration day there was not an atom of meal in the stores. For myself, it does not matter; I buy what I want and pay for it out of my pocket. But the slaves, the plantations—what is to become of them?"

Worn-out and decrepit, with exhausted strength and depleted resources, Storm was to render his masters and his country one final and signal service. Early in August, 1772, a month after his release had been decided upon in Zeeland, the old Governor foreshadows trouble, hints at its cause, and explains his humane and statesmanlike efforts to stem it. But the storm burst, and once more the colony was, by a serious slave rising, brought to the brink of total ruin.

As I have said already, Storm was before all, and throughout all, a soldier. Never do we find so manly a ring in his letters home as when, in words decisive and incisive, he had to report measures taken by him in great emergencies or in the face of mortal danger. A revolt of the slaves—an ever-present menace in those days to a colony's existence—or a report of a Spanish squadron off the coast, and Storm, assuming military command quite naturally, would be marshalling his puny forces, rousing the unwarlike burghers to a sense of their duty, and meanwhile writing to the directors, all coolly but energetically, for aid—that never came.

His despatches of August and September, 1772, are all that such documents at such a time should be—exactly explicative of events and measures taken, commendatory of those who had distinguished themselves in valour, and advisory respecting future means of defence. His successor arrived in the colony in November, 1772, and Storm's career was over—*salvis honoribus*, as he had so ardently wished. He immediately retired to his plantation in Demerara, where he died August 14th, 1775, at the age of seventy-one, unknown already then to men of his own generation in his own country, which he had not visited for twenty-five years, utterly forgotten but a little later. His grandson (the only son of his eldest son) married in the Netherlands, and Storm's great grand-daughter, named Constantia Lumea, like his wife, became a Baroness van Pallandt van Beerse, allied to a descendant of Storm's old colonel, and mingling Storm's blood with that of one of Holland's most illustrious families.

The two qualities that stand out most conspicuous in Storm's nature are loyalty and incorruptibility, and better qualifications than these no Governor could have; based, too, in his case, the one upon a keen sense of honour, the other upon true piety—unshakeable foundations that were further cemented by an unmercenary spirit, untiring industry, abstemious habits, and a mode of life both strenuous and simple.

In 1746 Storm writes:—

"I live in middle-class fashion, my fare is ordinary, nay, mean, for even no wine is drunk except when there is a Church or Court meeting; I dress rather below than according to my station."

In 1762 we find him (after twenty-four years' service in the colony) inhabiting a "very small" house, "consisting only of two rooms twenty feet square and a vestibule," and a year later he says:—

"I am compelled to hold the Court meetings in the preacher's house, because there is no room in mine."

Simple and abstemious enough then as was that life the strenuousness of which has been amply proved, material reward was not the object of Storm's ambition. In 1763, after twenty-five years' work for the company, he is able to say to the directors:—

"Riches I have never hunted nor sought after, and during such long service I have never troubled Your Honours for the least increase of salary."

Mercenary indeed could not have been the man who, when daily expecting his release from office, wrote in 1771 as follows:—

"This would be an excellent year for the sales-master"—this was one of the offices he undertook in addition to the Governorship—"his dues amounting to more than 15,000 guilders, but I have good reason to fear that two-thirds of it will remain in default through non-payment and protested bills. I cannot bring myself to complete the ruin of those who, through no fault of their own, have got into deep water, and render them unable ever to get out again. I should not care to go down to the grave with their curse upon me. My children have, thank God, a crust of bread (which the Lord deign to bless), and for the rest they must do their best and trust in Him who rules all in His Omnipotence."

It is not surprising to find that the possessions of a man cherishing such sentiments were sufficiently meagre considering the length of his

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career and the accumulation of his offices. In 1765 he writes:—

"It is perfectly impossible for me to exist at present upon my income, and I must get further into arrears every year; I am now already indebted for over three thousand guilders."

That there were means of amply rectifying the Company's parsimony is proved by a few simple but significant words Storm wrote home in November, 1770:—

"A certain gentleman came here to grease my palm, offering me 6,000 guilders"—that was £500, in order to get him to pass in 450 smuggled slaves —"this," he says, "I refused."

The entry upon such devious paths was, indeed, quite incompatible with a nature that held piety and pure dealing in equal honour, and honour itself "dearer than all else."

Almost every page of Storm's despatches shows how great a part religion played in his life, and of his life honour was the breath. But, as all men have the vices of their virtues, so did Storm's regard for honour lead to his one weakness—hyper-sensitiveness to opinion and hence even to calumny. "*Mens sibi conscia recti* has no need to fear calumny," he himself wrote in 1767; and, indeed, a greater disregard for the petty spite and interested cabals of the smaller men around him would have left his mind and pen more leisure to deal with larger problems and the future he was helping to shape—his body the greater repose which a tropical clime demanded; much might then have been otherwise in that administration with which he had to deal, though the tremendous odds he had to fight in the lethargy of the Company and the disloyalty of the colonists must never be forgotten.

In 1781, six years after Storm's death, war broke out between England and the Netherlands, and one of the first of our successes in the West Indies was the capture of Demerara; this was followed by the fall of Essequibo and Berbice. Between that time and the end of the eighteenth century the three colonies repeatedly changed owners, but in 1803 they once more fell to the British, whose hands they never left again, being finally ceded under the Treaty of 1814. In 1831 Berbice was united with Demerara and Essequibo; henceforth they were but three counties or provinces of British Guiana.

Immediately following that unification came the most interesting and complete series of explorations ever undertaken in the country. Robert Schomburgk was first sent out by the Royal Geographical Society as a result of a resolution taken in 1834 to explore the interior of the colony, this project having received the fullest sanction and patronage of His Majesty's Ministers. On his return to England in 1839 Schomburgk's representations as to the needs of the Indians in the south-west of the colony, and to their danger from Brazilian raiders decided the British Government that steps must be taken to stop further interference with the natives and violation of territory which was believed to belong to Great Britain. It was therefore resolved to send Schomburgk to make a complete exploration of the boundaries of British Guiana and to mark them provisionally.

Subsequent negotiations with the Venuezuelan and Brazilian Governments, however, came to a premature end without any result, and the reports of Schomburgk's surveys with the fine maps he produced lay buried for nearly half a century.

In 1886 the British Government declared the Schomburgk line to be the definitive boundary of the colony, this leading to the suspension of diplomatic relations with Venezuela in the early part of 1887, but it was not until December, 1895, when President Cleveland issued the celebrated Message, in which he called upon Great Britain to submit the whole question of the boundary to arbitration, that matters came to a head. After more than two years of preliminary argument on paper, a tribunal met in Paris in 1899, and a judgment was given which, in effect, sustained the whole claim of Britain to the Schomburgk line—a line which would have fairly satisfied the claims made by the old Governor Storm some 140 years before.

Negotiations with Brazil were actively prosecuted as soon as the award in the Venezuelan matter had been given, and these resulted in another treaty of arbitration, and in an award that may also be claimed as a considerable triumph for the line drawn by Schomburgk. Thus, by the end of 1906, only five years ago, British Guiana for the first time had its boundaries definitely fixed, and though those boundaries almost certainly did not go so far as Dutch influence at one time went, still they included most of the territory for which Storm van 's Gravesande had always contended, and to the defence of which he had devoted his life.

DISCUSSION.

Sir Everard im Thurn, K.C.M.G., in opening the discussion, said the subject of the paper was of very great interest to him, as he had spent about twenty of the best years of his life in acquiring

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knowledge of the Venezuelan question. He lived in the country at the very places where Storm van 's Gravesande lived and worked, and followed the lines along which Schomburgk afterwards journeyed. Having acquired that information, he was called home to spend two years of his time in further preparation, and he then became acquainted with Mr. de Villiers, who had unburied, not in the colony, but in the archives at home, an immense mass of information which threw light upon the facts that he had been observing upon the spot. He had listened with the greatest admiration to the paper for several reasons. It seemed to him that, quite apart from the value of the author's work in regard to the settlement of the boundary, he had done a literary service in presenting a picture in such detail of a man as interesting as Storm was. He had seen a great many of Mr. de Villiers' translations of Storm's writings, and could assure the audience that, in addition to the facts which the author laid before them in his paper, Storm's despatches teemed with familiar domestic details which would serve to make a most interesting book on the subject. But, in addition to that, he thought the author's work had been most useful to all whose fate it was to study the development of the British colonial system. During the course of his life he had had a great deal to do with that subject, and had always found there were certain definite stages to be observed in the history of every colony, whether it began as a British colony or was afterwards assumed by the British. Those earlier stages were roughly three in number, the first being the unauthorised settlement of people in a place where before only natives had lived. The second stage was that in which an official, with extraordinarily inadequate means, was trying to keep in order those unauthorised settlers, who had generally been a very disorderly lot, and regulating their relations with the natives. That sort of work, which was done for so many years so strenuously by Storm was most important, but at the same time most difficult and trying, and his admiration for the way in which Storm carried out that work was unlimited. The third stage arrived when the Home Government gave the governing authority in the colony complete power, and when it established in the colony some sort of constitution and means of keeping order. That stage was carried out to a very great extent by the Dutch in Guinea before the British took it over; and the old Dutch constitution of Guiana, which this country took over in 1803, although the acquisition was not confirmed till 1814, survived with all its forms, without any change, until about thirty years ago, and was unique among British colonies. In some respects, in its retention of Roman Dutch law and Roman Dutch coinage and measures, there were points of resemblance with the Cape and the Ceylon Governments, which were originally Dutch; but in no part of the British Dominions was there so c mplete a specimen of a Dutch onstitution as that which existed in British Guiana from the beginning of the last century until about 1880. He desired to make a few remarks—not by way of criticism of anything the author had said, because he had found nothing in the paper which he could adversely criticise—but there was one small point the author mentioned about which he (the speaker) had spoken and written on previous occasions which did not seem to be realised. He referred to the curious Lake Parima, as it used to be called, or Lake Amuku, as it was known at present, which Raleigh, and so many of the old atlas makers, exaggerated to such a large extent and made to occupy nearly the whole of the interior of Guiana. The nature of that lake had not even yet been fully understood. Schomburgk's journals, which were published almost *in extenso* by the Royal Geographical Society between 1839 and 1845, had practically never been read until they were perused most diligently for the purposes of the Venezuelan Boundary Commission. Since then they had been almost forgotten again. Schomburgk's account of Lake Amuku must, he thought, have been misunderstood then, and it was no better understood now. He had many times been over the plain on which Lake Amuku was situated, and had lived in the district for six months at a time, and he found there was nothing which, except with a very great stretch of imagination, could be called a lake. In Horstman's map, which illustrated the paper, it would be seen that there were two river systems, the one going into the sea through the Essequibo, and the other beginning with the Pirara and the Mahu, running down to the Rio Negro and eventually out through the mouths of the Amazon. It would be seen that both of those systems started in a plain, in the centre of which was Lake Amuku as shown in the map. There was no such definite sheet of water as was shown there, and as was generally supposed to exist. The whole of the country between those river heads was one swampy, grassy plain in which the tiny streamlets at the head of the Pirara, and the head of various other streamlets going down through the Essequibo, rose, but at no time during ordinary dry seasons was water to be seen. If one walked through the long grass on the plain one's feet sank into the water; water splashed up round the ankles, but under ordinary circumstances there was no lake there. In heavy rainy seasons, however, the water rose, although not over any small definite area like that shown on the map, but over the whole plain. He had walked in a diagonal direction right across the plain from one side to the other, with the water never above his waist, and generally not above his knees; so that he knew from practical experience that, although a swamp existed which occasionally carried a small quantity and at other times a large quantity of water, there was no such thing as a definite lake there. The author had stated that the boundary between British Guiana and Spanish Guiana, or Venezuela, had been definitely settled, and the boundary between British Guiana and Portuguese Guiana, or Brazil, had also been settled; but, curiously enough, the whole of the

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boundaries of British Guiana had not even yet been settled. There was still some considerable difference of opinion with regard to the boundary on the Upper Corcutyne between British Guiana and what was still Dutch Guiana, or Paramaribo. The question had been raised as to where the boundary existed there, but it had never been settled up to the present day, so that it was not quite accurate to say that British Guiana now enjoyed a definite boundary. That was of interest in connection with his earlier remarks that there were three stages of development in a colony, namely, the settler stage, the getting-into-order stage, and the final constitutional stage. There was another stage generally later than that, and it was only in that later stage that the boundaries of a colony were settled. In British Guiana the final definite stage had not yet been reached in which it was exactly known what territory constituted British Guiana, and what belonged to its neighbours.

The Chairman (Lord Reay), in proposing a cordial vote of thanks to the author for his extremely interesting paper, said it was difficult to understand at the present day, when people were able to read in their evening papers what the King-Emperor and the Queen-Empress had done on the same morning in Bombay, how governors in the colonies did their work when they had to wait for months until they received an answer to their despatches in the nature of instructions. To a certain extent that drawback often had its compensations. Speaking from his own experience, although a governor, on the one hand, had less responsibility when he was in constant telegraphic communication with his masters, on the other hand very often the man who was on the spot, who ought to be trusted, was hampered by considerations of a political nature at home, and by questions asked in the House of Commons which influenced, as they perhaps ought not always to influence, the policy which had to be pursued. Storm evidently was a very remarkable man, and a very good representative of those Dutchmen who had done so much to found the Dutch colonial empire. He had been very much struck with Storm's attitude towards the Indians, and the importance he attached to the cultivation of friendly relations with them. He hoped the author's paper would reach South Africa, and that the Government of that colony, taking a leaf out of the record of Storm van 's Gravesande, would follow the same principles in their relations with the Indian subjects who settled in South Africa. The problem was a very difficult and delicate one, but he thought it ought to be solved in the same way that Storm solved his. One very remarkable point was the latitude which was given both to the West India and the East India Companies in the Netherlands. It had always been a matter of surprise to him that those Companies, each of which was practically an *imperium in imperio*, were allowed such great latitude for so long a period, because it must not be forgotten that their actions could, as the paper showed, lead to international difficulties. It was quite obvious that whatever was done by Storm with regard to his relations with Spain would and might place the Government at the Hague in difficulties with Spain, and it showed the great tact which Storm displayed under most difficult circumstances that no greater difficulties were created. Another extremely important matter was the way in which Storm not only allowed, but even encouraged, English settlers in Guiana, a very wise policy which had always been followed by the Netherlands. English settlers had always been freely admitted in Java, and a great benefit had resulted from the free trade which existed in the Archipelago. In many other colonial empires preferential trade existed between the mother country and the colonies, whereas in the Dutch possessions there was absolute freedom, and a very moderate tariff, which was greatly to the advantage of the British nation. He was glad to hear from Sir Everard im Thurn's remarks that there was a chance of still another arbitration taking place, which he hoped would be as successful as its two predecessors, for settling the frontier. He had no doubt that an arbitration between the Netherlands and Britain with regard to the frontier which had not yet been settled would be of the most amiable kind, and would have the same result that all arbitrations hitherto had had between various nations, namely, to render the subsequent relations of the two countries more friendly and cordial. The immense advantage which had resulted from the Newfoundland arbitration with the United States was a case in point. In conclusion, it gave him great pleasure to move a hearty vote of thanks to the author for his admirable paper, which gave such a clear and absolutely fair view of a great Dutchman.

The resolution of thanks having been carried,

Mr. J. A. J. de Villiers, in reply, after thanking those present for the cordial manner in which they had passed the resolution, said that Sir Everard im Thurn had stated that Lake Amuku was shown on the maps to be very much larger than he found it to be. He thought the fact should be taken into consideration, however, that the map was drawn by Horstman in 1739 or 1740, and it was quite possible that the swamp had dried up considerably in the 150 years which had since elapsed. With regard to the boundary that was not yet settled, he had always heard that it was a tradition in the Foreign Office that Lord Salisbury would not allow there was any question about the matter at all; that he regarded that piece of boundary as finally settled; and that, however much the Netherlands might be disposed to open the question, this country would always resolutely set its face against it. If, however, such an arbitration was held, he would be only too happy to place his services at the disposal of the Government.

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HOME INDUSTRIES.

The Case of the "Oldhamia."—The owners of the "Oldhamia" have, in the form of a pamphlet, submitted their case as against Russia to the verdict of public opinion which will sympathise with them. The lessons to be drawn from the case are of the highest importance to British industries, the facts being undisputed. Briefly, the "Oldhamia" was a Manchester ship destroyed by the Russians in the war with Japan. She was owned by the Manchester and Salford Steamship Company, Ltd., and was in 1905 carrying a cargo of petroleum owned by the American Standard Oil Company. Near the island of Formosa she was captured by the Russian cruiser "Oleg," searched, and eventually sent on to Vladivostock with a prize crew on board. They navigated her so carelessly that she ran on a sandbank, and the officer in charge, without attempting to get her off, set fire to her and destroyed her. She burned for a month, and the Russian officer stood by for the whole time watching her burn. The loss was estimated at over £60,000, and the owners claimed compensation from the Russian Government. At the instance of Lord Lansdowne the owners brought their claims before the Russian Prize Court at Libau. "If after legal remedies have been exhausted a denial or miscarriage of justice is apparent," wrote his lordship, "the propriety of diplomatic intervention will be considered." The Russian Prize Courts refused compensation, and diplomatic assistance was again requested from the British Foreign Office. Sir Edward Grey, on December 19th, 1909, said that it would be given, and on January 4th, 1910, he instructed the British Ambassador at St. Petersburg to inform the Russian Government of the "entire dissent" of the British Government from the findings of the Prize Courts, and on August 27th, 1910, the owners were informed by Sir Edward Grey that he had urged the Russian Government, in default of compensation, to consent to the case being submitted to arbitration by the International Tribunal at the Hague. The Russian Government refused, and on November 8th last the owners received a letter from Sir Edward Grey in which he informed them of this refusal and added that "no useful purpose would, in the opinion of the Secretary of State, be served by attempting to reopen the case." It is not necessary to go into its merits, though it may be said that in the opinion of the best authorities in this country it cannot be reasonably contended that the lighting petroleum carried by the "Oldhamia" was capable of being used as fuel, and therefore liable to capture as "conditional contraband," and even if the contrary could be shown the condemnation was illegal, because the particular cargo was consigned to a private person, and no evidence was offered to show that it was destined for public use. Moreover, the burning of the ship was an act of piracy, and the captor was bound to make compensation without respect to the question whether the capture was valid or not, since there was no pretence that the failure to destroy would involve danger to the safety of the warship, or to the success of the operations in which she was engaged at the time. The lesson to be drawn from the "Oldhamia" case is that such cases ought not to be decided, so far as judicial proceedings are concerned, by the court of one of the interested parties alone. As matters stand, the question as to the legality of the capture, and the propriety of the captor's action, is tried solely in the courts of the belligerent captor. The neutral has no appeal beyond the courts of the country against whose agent he is bringing his action. "Diplomatic action" is of no use. An ultimatum is the next step, and an ultimatum would probably mean war, and to declare war because the Russian Supreme Court gives a judgment which we consider unjust would obviously be out of the question. The case of the "Oldhamia" demonstrates very forcibly the importance to neutral shipping of securing a trial on appeal to a court composed in the majority of neutrals, and it was this consideration that led the British Government to support the scheme for the establishment of an International Prize Court at the Hague. If the Declaration of London is ratified, cases of capture of neutral ships will be sent on appeal to such a court, where the neutral involved will be represented.

Railway Fares.—It was recently mentioned in these Notes as probable that, in order to meet their increased wages bills, the railway companies might find it necessary to increase passenger fares, and it is now stated that they are preparing for an increase. The financial position of most of the lines will not permit of proposed concessions to the employees unless they can be made good by an increased revenue, and it is said to be the present intention to increase fares at varying rates from 5 to 12½ per cent., and to confine the increase, at any rate at first, to special traffic like week-end tickets and excursions.

Shipbuilding on the Thames.—It is still thought possible in some quarters that the Government may reconsider their decision and give an order for another battleship to be built on the Thames. The difficulty in the way is that work cannot be executed as cheaply on the Thames as elsewhere. There was the same trouble forty years ago, when Samuda Bros. had a yard in the river. For a time they did well, but prices fell and the Admiralty offered Mr. Samuda a contract to build a battleship at a price which would leave a loss. He was not prepared to take the loss, but he called his men together and explained the position. If they were to be paid at the current rate of wages, somewhere about 7*s.* a day, there would be a loss of several thousand pounds; if they would accept 1*s.* a day less the accounts would balance and the firm would take the order. If the men doubted the figures they might call in an independent accountant to verify them, but the men, under union rules, declined, as they would no doubt decline to-day if a similar offer was made to them.

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The Cotton-holding Scheme.—According to Messrs. Neill Brothers, "a leading New York firm is reported to be endeavouring to form a syndicate for the purpose of assisting the South to hold the remainder of its cotton for higher prices. The method is to be for planters to make over their cotton to the syndicate, receiving an immediate advance of £5 per bale, and 75 per cent. of any profit shown when the cotton is ultimately sold. In return the planter is now to promise to reduce his acreage next season by 25 per cent. It strikes us that this is an absurd suggestion. Planters as a class are now fairly well to do, and able to hold a fair proportion of their own cotton if they wish; and if they need assistance there is plenty of loose capital in the South ready to advance much more than £5 per bale on cotton now presumably worth £9 to £10. Why, then, should the planter deprive himself of the use for next year of one quarter of the land which now yields him, say, £9 per bale in order to obtain an advance, which he does not require, of £5 per bale? May not the effect of this New York effort rather be to suggest to the shrewd planter that he had better hurry up and take the £9 or £10 per bale which he can now obtain by selling his cotton, rather than give it into the hands of people who value it so low as a security as £5 per bale or 2½*d.* per lb.? The proposal, however, if seriously meant, only shows to us what fears must be felt of the excessively large crop unduly depressing the prices of cotton when such artificial methods are resorted to in order to raise them."

Threading Weaver's Shuttles.—Mr. J. Hester and Mr. W. H. Horrocks, of Prestwitch, have applied for protection of a new way of threading weaver's shuttles. The invention is a shuttle in which the hole is large enough for the thread to be pushed through with the finger. The shuttle is drilled through crossways near the tip and a piece of brass tubing is inserted. This has a hole cut in it at the top. To thread this shuttle the weaver makes his knot of thread with his first two fingers, pushes it through the top hole with his forefinger, and then out of the tube at the side with his little finger. It is claimed that the movement is as easy and as quick as sucking, and sucking is impossible with this form of shuttle. The thing may be used as either a right or left hand shuttle. It is said that existing shuttles can be readily converted, and that a number are already in use in various sheds.

CORRESPONDENCE.

AEROPLANE EFFICIENCY.

In the discussion on aeroplanes reported in your issue of December 1st, it is stated that the Aircraft Factory chart, for which I not unnaturally took credit, was anticipated in 1903 in France. From a mere recollection of resemblance, Mr. A. R. Low asserts that there was, *therefore*, anticipation. I propose to state what the Aircraft Factory chart showed about an aeroplane, and to invite proof of the prior claim.

It showed body resistance and wing resistance at all angles and speeds, it showed the best climbing speed and how to select it, the best speed for minimum petrol consumption, the best speed for gliding, *i.e.*, the best gliding angle, the available margin of horse-power at each speed, the total range of speed of the aeroplane in question. It was not a theoretical case, but was verified by trials on the design at Farnborough. It was not a single case, but was plotted for three aeroplanes reconstructed at the Aircraft Factory, and for three well-known foreign makes.

It is now for Mr. Low to prove what he says.

MERVYN O'GORMAN,
Supt. of H.M. Aircraft Factory.

GENERAL NOTES.

THE SILK ASSOCIATION OF GREAT BRITAIN AND IRELAND AND THE INSURANCE BILL.—This Association has issued a statement as to the effect the National Insurance Bill, if passed in anything like its present shape, may be expected to have upon the silk industry. The competition of France, Germany, Italy, and even the United States, is very keen, and the position of the silk trade is such that "even a small burden upon the industry becomes a serious factor in the keen competition with foreign manufacturers which now exists." The complaint of the silk manufacturers is that the Bill does not recognise the fundamental difference which exists between the conditions of male and female labour, and that silk manufacturers who employ a large proportion of females as compared with males are especially penalised by any disadvantages under which the employer of female labour will suffer under the Bill. Out of one hundred boys who commence learning a trade, the majority become more or less efficient workmen, but of every hundred female learners only a small proportion, estimated in various trades at from 20 to 50 per cent., remains available to the employer. This operates upon the employer of females very inequitably under the Bill, as the increased proportion of female learners compared with male learners means an increased proportion of those earning a learner's wage. Under the proposed Bill the employer has to pay 3*d.* weekly for all employees between sixteen and twenty-one years of age. Thus the weekly payment by the employer for a girl learner earning 5*s.* weekly is the same (3*d.*) as the weekly payment by the employer of male workers earning, say, 30*s.* weekly. From actual returns made by twenty-three of the chief silk factories of the United Kingdom, it is found that the employers' contribution for female employees will cost 2·838 per

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cent. on their wage bill, whereas the cost to employers of male labour amounts, in most cases, to less than 1 per cent. In some sections of the silk industry, the cost to the employer for his female workers amounts to 5 per cent. on the wage bill. Nor can it be said that the employer of female labour is making a larger proportionate profit than the employer of male labour. The amount paid in wages under competitive conditions to various classes of labour is approximately in proportion to the earning power to the employer of the labour in question. The Association contends that, bearing in mind the facts that one female out of every two ceases work after a few years to become married, that the period when such females are at work is the healthiest period of their lives, and that every such person creates what may be termed a lapsed policy, no justification is to be found in the Bill, or in the report of the actuaries, for the proposed total of *6d.* jointly contributable by the employer and the employee.

MEETINGS OF THE SOCIETY.

Ordinary Meeting.

Wednesday evening, at 8 o'clock:—

December 13.—W. Yorath Lewis, M.Am. Soc.M.E., A.M.I.Mech.E., A.M.I.E.E., "Continuous Service in Passenger Transportation."

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

December 14.—J. Travis Jenkins, Ph.D., D.Sc., Superintendent of the Lancashire and Western Sea Fisheries, "Fisheries of Bengal." Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., will preside.

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Professor Vivian B. Lewes, "The Carbonisation of Coal." Four Lectures.

Syllabus.

Lecture III. — December 11. — *The Thermal Conditions existing during the Carbonisation of Coal.*—The heat of formation of coal—The work of Euchene, Mahler, and others—The cause of the endothermic nature of some coals—The thermal value of the reactions taking place in the retort—The losses of heat in a retort setting—The transmission of heat through the retort and charge—The effect of temperature and travel on the primary products of decomposition — The temperatures existing in retorts and ovens—Small charges and full charges—The influences which lead to improvement in the products from full charges, chamber and vertical retorts.

Lecture IV. — December 18. — *The Possible Improvements in Carbonisation.*—The aims of the gas manager and coke producer—Experiments on low temperature distillation and their teaching—The rivalry existing between fully-charged retorts, vertical retorts, recovery ovens, and chamber carbonisation — The intermittent vertical retort *versus* the continuous vertical systems—The Settle-Padfield, Duckham-Woodall, and Glover-West processes—The ideals of carbonisation—The volume of gas due to primary and secondary reactions—The gasification of tar—The limitations of volume and quality of gas—The ends to keep in view in devising new processes of carbonisation.

Papers to be read after Christmas:—

Cecil Thomas, "Gem Engraving."

F. Martin Duncan, "The Work of the Marine Biological Association."

H. A. Roberts, M.A., "The Relations of Science to Commerce and Industry."

John Nisbet, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

Frank Warner, "Silk."

Charles C. Allom, "The Development of Artistic Skill in the Applied Arts."

Cyril Davenport, "Illuminated MSS."

Ernest Kilburn Scott, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

Charles Bright, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

Harold Cox, "The Interdependence of Morals and Economics."

Professor G. W. Osborn Howe, "Recent Progress in Radio-Telegraphy."

E. D. Morel, "British Rule in Nigeria."

Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Theodore E. Salvesen, "The Whaling Industry of To-day."

Leonard Hill, M.B., F.R.S., and Martin Flack, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

Professor Ernest A. Gardner, M.A., "Greek Sculpture."

George Fletcher, "Technical Education in Ireland."

Colonel Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India."

The Rev. Walter K. Firminger, B.D., Senior Chaplain, Bengal Establishment, "The Old District Records of Bengal."

E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

Walter Saise, D.Sc., M.Inst.C.E., F.G.S., "The Coal Industry and Collier Population of Bengal."

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NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

ALAN BURGOYNE, M.P., "Colonial Vine Culture."

JUVENILE LECTURES.

Wednesday afternoons, at 5 o'clock:—

CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." Two Lectures.

Syllabus.

LECTURE I.—JANUARY 3.—The surface actions of water and other liquids—Peculiar properties of solutions of soap and of saponine with which bubbles may be blown—The strength of bubbles—Soap films on frames—Froth—Composite bubbles.

LECTURE II.—JANUARY 10.—Out-of-door bubbles—Floating bubbles—Soap bubbles as an aid to experiment—Experiments with soap bubbles—The colours of soap bubbles—Permanent celluloid films showing the colours of soap bubbles.

The Lectures will be illustrated by numerous experiments.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 11...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "The Carbonisation of Coal. Lecture III.—The Thermal Conditions existing during the Carbonisation of Coal."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 8 p.m. Mr. James Farley, "The Standardisation of Vitrified Ware Pipes."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. G. R. Seton, "Appliances used in the Retailing of Beer, and their Proper Use."

Economics, London School of, Clare Market, W.C., 5 p.m. Dr. M. Phillips, "State Insurance."

Surveyors, 12, Great George-street, S.W., 5 p.m. Mr. W. A. Haviland, "The Burden of Upkeep on Rural Estates and its Relief under Section 69 of the Finance Act, 1910."

Post Office Electrical Engineers, Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 6 p.m. Mr. E. A. Pink, "Distribution by Means of Parallel Cables."

Victoria Institute, 1, Adelphi-terrace House, W.C., 4.30 p.m. Dr. Ludwig von Gerdtell, "Natural Law and Miracle."

London Institution, Finsbury-circus, E.C., 5 p.m. Miss R. Travers, "Finland."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. A. E. Munby, "Is the Texture of Materials a Fetish?"

Alpine Club, 23, Savile-row, W., 8.30 p.m.

TUESDAY, DECEMBER 12...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Miss Mabel Atkinson, "Domestic Life and the Consumption of Wealth."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. V. A. Smith, "Indian Painting from the XVI. to the XVIII. Century."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Dr. T. E. Stanton and Mr. J. R. Pannell, "Experiments on the Strength and Fatigue Properties of Welded Joints in Iron and Steel."

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Professor H. G. Greenish, "Caraway Cultivation in Holland." 2. Mr. G. Claridge Druce, "A Visit to Japan."

WEDNESDAY, DECEMBER 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Yorath Lewis, "Continuous Service in Passenger Transportation."

Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m.

Automobile Engineers, 13, Queen Anne's-gate, S.W., 8 p.m. Mr. L. H. Pomeroy, "Engine Design for Taking Advantage of Horse-Power Rating Rules."

United Service Institution, Whitehall, S.W., 3 p.m. Captain Sir T. A. A. Cuninghame, "Mechanical Transport in the Field."

Japan Society, 20, Hanover-square, W., 8.30 p.m. Dr. A. Westarp, "Japan ahead in Music."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Professor Henry Newbolt, "Poetry."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Major H. B. Strange, "Steel Specifications considered Commercially."

China Society, Caxton Hall, Westminster, S.W., 8.30 p.m. Rev. J. Macgowan, "The Drama in China."

THURSDAY, DECEMBER 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Dr. J. Travis Jenkins, "The Fisheries of Bengal."

Cyclists' Touring Club (Metropolitan District Association), at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. H. Small, "Through Normandy and Brittany on a Cycle."

Royal, Burlington House, W., 4.30 p.m.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Mr. G. C. Workman, "Some Recent Works in Reinforced Concrete."

Early English Text Society, in the Theatre, King's College, Strand, W.C., 5.30 p.m. Mr. H. B. Wheatley, "Dr. Furnivall and the Work of the Early English Text Society."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Emile Lesage, "A Frenchman's View of England."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Rev. T. T. Norgate, "Joan of Arc."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. A. E. Seabrook, "Residence Tariffs."

Mathematical, 22, Albemarle-street, W., 5.30 p.m.

FRIDAY, DECEMBER 15...British Academy, in the Theatre, Burlington-gardens, W., 5 p.m. Professor R. A. Stewart Macalister, "The Philistines, their History and Civilisation."

Engineers and Shipbuilders, North-East Coast Institution of, Bolbec Hall, Newcastle-on-Tyne, 7.30 p.m.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Discussion upon paper by Mr. J. Hartley Wicksteed, "Double-Cutting and High-Speed Planing Machines." 2. Mr. R. Godfrey Aston, "Oil-Burning Locomotives on the Tehuantepec National Railway, Mexico."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. E. F. Hunt, "Tests on Reinforced Concrete."

SATURDAY, DECEMBER 16...Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m. (Graduates' Section.) Mr. C. Ian Burrell, "Design and Construction of Aeroplanes."

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Journal of the Royal Society of Arts.

No. 3,082. VOL. LX.

FRIDAY, DECEMBER 15, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 18th, 8 p.m. (Cantor Lecture.) Professor VIVIAN B. LEWES, "The Carbonisation of Coal." (Lecture IV.)

CANTOR LECTURES.

On Monday evening, December 11th, Professor VIVIAN B. LEWES delivered the third lecture of his course on "The Carbonisation of Coal."

The lectures will be published in the *Journal* during the Christmas recess.

INDIAN SECTION.

Thursday afternoon, December 13th; Sir STEUART COLVIN BAYLEY, G.C.S.I., C.I.E., in the chair. A paper on "The Fisheries of Bengal," was read by Mr. J. TRAVIS JENKINS, Ph.D., D.Sc.

The paper and discussion will be published in a subsequent number of the *Journal.*

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 3rd and 10th, at 5 o'clock, by CHARLES VERNON BOYS, F.R.S., on "Soap Bubbles."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who require tickets for the course are requested to apply for them at once.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, December 13th, 1911; CAPTAIN G. S. CAMPBELL SWINTON in the chair.

The following candidates were proposed for election as members of the Society:—

Burns-Begg, Colonel Robert, The Residency, Salisbury, South Rhodesia, South Africa.

Cochrane, His Honour Judge Andrew January, Maysville, Kentucky, U.S.A.

Hart, William Edward, M.A., J.P., Kilderry, Londonderry, Ireland.

Heming, Arthur, 8, James-street North, Hamilton, Ontario, Canada.

McKerrow, George, M.D., 7, Barns-street, Ayr, Scotland.

Morgan, G. S. Delmar, B.A., Kuala Lumpur, Selangor, Federated Malay States, and Thatched House Club, St. James's-street, S.W.

Tubby, Alfred H., M.B., M.S., F.R.C.S., 68, Harley-street, W.

Veitch, Henry Newton, 22, Old Burlington-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Costello, John Francis, B.A., Camp, Sholapur, Deccan, India.

de Villamil, Lieut.-Colonel Richard, Carlisle Lodge, Rickmansworth.

Foord, Charlton Willoughby Hougham, 23, Kitson-road, Barnes, S.W.

Harrop, Edwin, 109–119, Rosebery-avenue, E.C.

Heath, Dudley, Pembroke Lodge, Winchmore-hill, N.

Huntsman, Henry William Tite, Rions, Northwick Park-road, Harrow, Middlesex.

Morgan, George, I.S.O., Downings, Wallington, Surrey.

Stout, Arthur Purdy, 574, Madison-avenue, New York City, U.S.A.

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The paper read was—

CONTINUOUS SERVICE PASSENGER TRANSPORTATION IN RELATION TO THE LONDON TRAFFIC PROBLEM.

By Wm. Yorath Lewis, M.Am.Soc.M.E., A.M.I.Mech.E., A.M.I.E.E.

At the recent Portsmouth meeting of the British Association, the author delivered a paper on "Continuous versus Intermittent Service in Passenger Transportation,"* and therein briefly indicated on the one hand that the characteristic of all systems of transport in general use—viz., "Intermittency"—is the root cause of their inherent limitations; their excessive initial and operating costs; and their inability to meet satisfactorily the requirements of the dense traffic usual in all great cities: on the other hand, that, by resorting to the continuous plan, the traffic could be handled in streams instead of in crowds with remarkable advantages in every respect. He further partially disclosed a new continuous system devised to perform services which cannot be met by the electric train, or any other system, whether "intermittent" or "continuous." In the meantime he has written a series of articles on "The London Traffic Problem"* in the *Daily Chronicle*, reviewing the situation, and indicating that the key to the solution of that problem may possibly be found in the "Adkins-Lewis System of Rapid Continuous Transit." Let us now consider the matter further.

* Copies of these are available in pamphlet form, and should be read in conjunction with this paper.

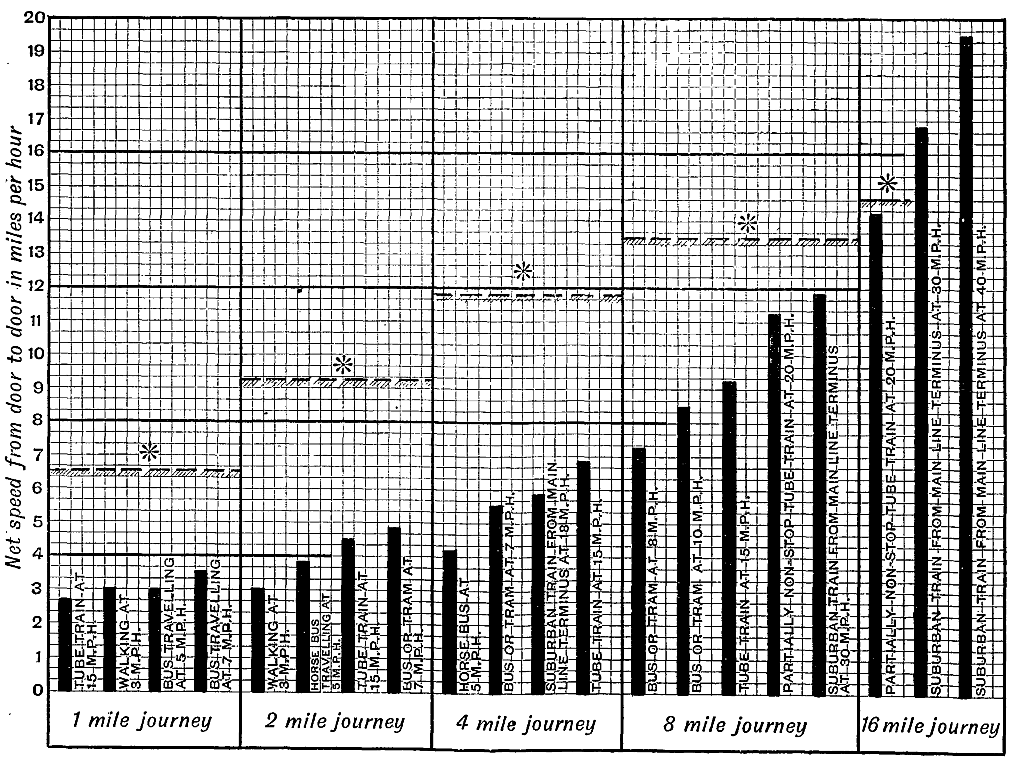

Fig. 1.—Effective "Door-to-Door" Speeds.

In this diagram it is assumed, for journeys *viâ* buses and trams, that four minutes are occupied at each end in walking and waiting before boarding and after alighting.

When the journey is *viâ* tube railways, six minutes are assumed to be occupied in walking to and from the nearest station, and six minutes in getting between street and train, and *vice versa* (owing to lifts, passages, etc.).

When for comparatively long distances the journey is *viâ* suburban or main line terminals, twelve and a half minutes are allowed at each end on the assumption that traveller has considerably further to walk.

* The effective door-to-door speeds that would be given by the Adkins-Lewis shallow subways, with four stations per mile, are shown by dotted line.

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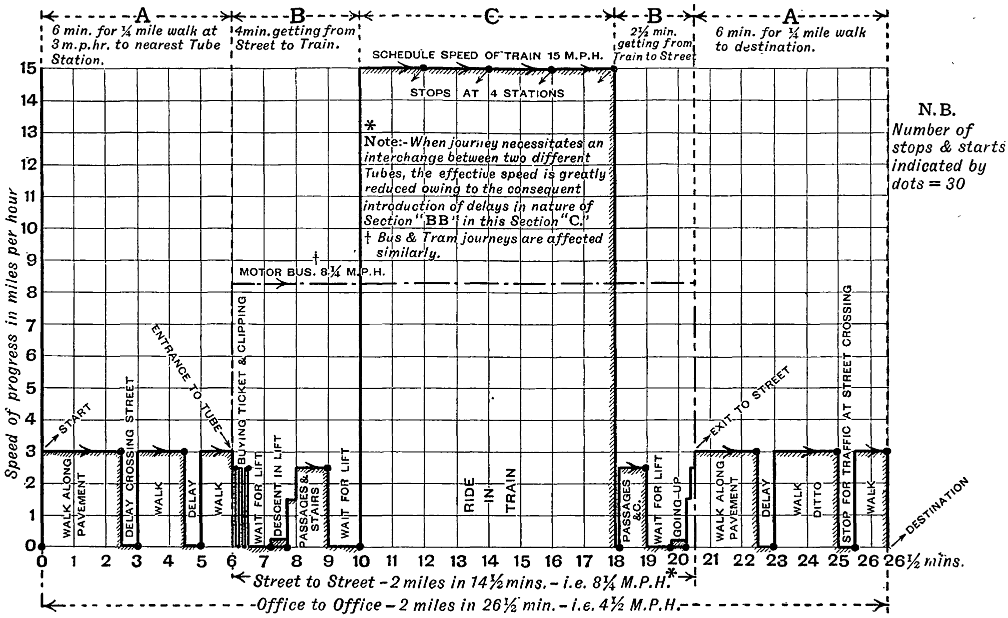

FIG. 2.—AVERAGE TWO-MILE JOURNEY "DOOR-TO-DOOR" SPEED, *viâ* TUBE RAILWAYS AND MOTOR BUSES.

NOTE that, in order to give schedule speed of 15 miles per hour on route having two stations per mile, the train has to attain a maximum or "crest" speed of about 25 miles per hour.

Referring then to the situation, but only very briefly, What is it? Nobody really knows! And, what is more, nobody can possibly find out. Even the Government have not the power to obtain the data necessary for a proper study of the problem in its entirety—in all its aspects. What everybody knows, however, is that there is a great deal of congestion and confusion in all directions. It is generally known also that ordinary passenger fares average six-tenths of a penny per mile.* Perhaps it is not so widely known that the effective speeds are ridiculously low—much lower than they are in New York, for instance. Let us see what the millions which have been sunk in tubes, trams, and buses provide Londoners in point of speed.

Fig. 1 gives the effective "door-to-door" speed attainable between destinations at various distances apart, when the journey is made by the different means. The effective speeds are so wretchedly low that there results a heavy and extravagant taxicab traffic. The demand for a cheaper mode of transit than taxis, and a more convenient and effective one than is furnished by the sub-surface facilities, especially for short journeys, results in a very dense motor-bus traffic. The density of street traffic is completed by an exceptionally heavy commercial and mail traffic, because practically all of this is street-borne. Of course, the resulting street congestion lowers the effective speed both of passengers and freight. Consequently all the individuals in the community, and especially traders and business men, suffer acutely. The net result is a colossal waste of time—an embargo on trade. Now London must see to it that the extent of this embargo on her prosperity is not greater than it is in other cities on their prosperity. In fact, London must do more. She must not only have the best and cheapest transit facilities, but must make for the greatest all-round efficiency.

But why is it that the effective speed about the central area is so inferior, when there is such a network of tubes having an intense service of 25 to 30 miles per hour trains, giving schedule speeds of 15 to 16 miles per hour? Let us examine Fig. 2. In the first place, owing to its characteristic—"Intermittency"—the electric train system is limited to not less than about half-mile distances between stations for the schedule speed of 15 or 16 miles per hour. Thus it is that the average journey to or from the nearest tube station is at least a quarter of a mile or a five or six minutes' walk (including street crossing delays) at three miles per hour. In the second place, the tube trains are run at intervals of from one and a half to three minutes, involving an inevitable wait. In the third place, the tubes

* See Table 2, Appendix F. iv. p. 137, Board of Trade London Traffic Branch Report, 1911.

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are situate at deep level, necessitating lifts operated intermittently, also involving delay. There are other items detrimental to efficiency, but, now referring to the diagram, we see that a journey from a City office to another one two miles distant involves so many delays that the effective speed overall (" door to door ") is only $4\frac{1}{2}$ miles per hour, whilst the " street-to-street " speed *viâ* the tube is only $8\frac{1}{4}$ miles per hour. Shorter journeys, of course, are worse.* The one often has to wait for accommodation; and the same is equally true of trams.

Now look at Fig. 3. This gives the effective "street-to-street" speed for tube railway journeys of various lengths, when the schedule speed of the train is 16 miles per hour, which is above the average in London on routes having two stations per mile. The effect of a six minutes' total time loss in getting between street and train, and *vice versa*, which is a fair average over

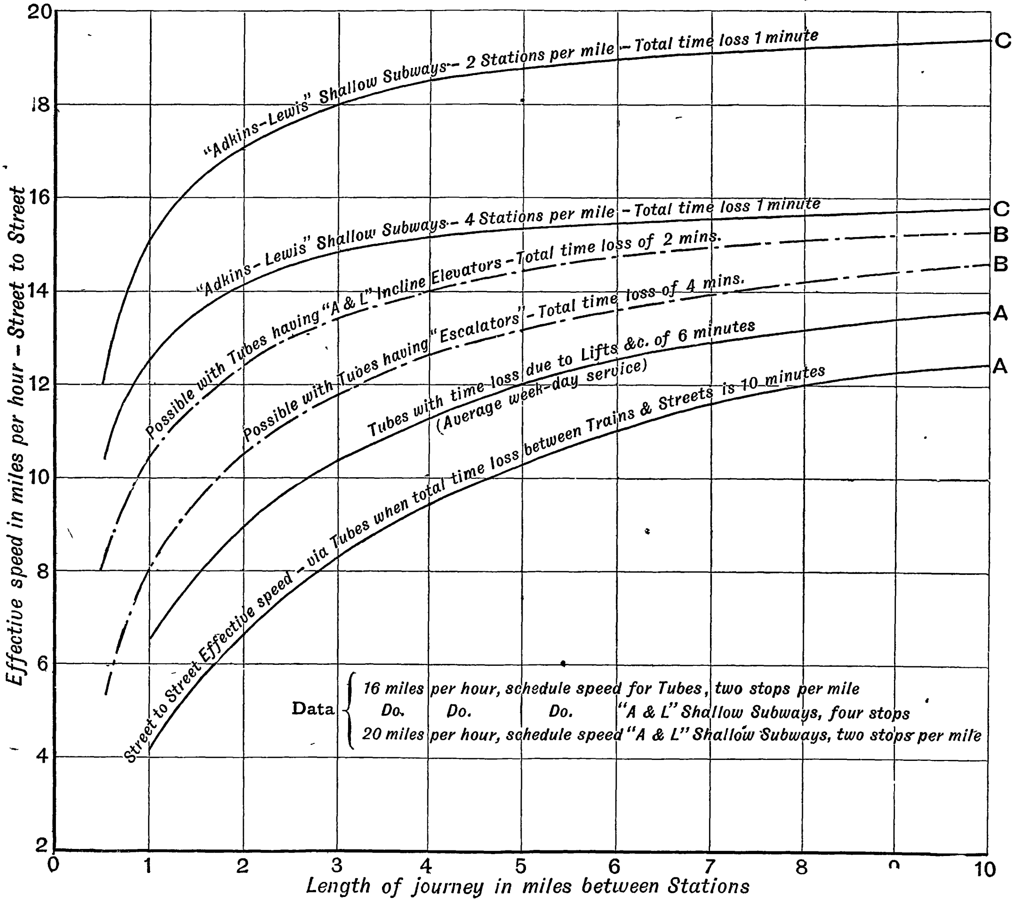

FIG. 3.—EFFECTIVE " STREET-TO-STREET " SPEEDS.

Curves AA—Tubes with present lifts.
,, BB—Tubes with continuous elevators.
,, CC—Adkins-Lewis subways.

diagram also shows the result of negotiating the same journey *viâ* motor-bus, and it will be noted that the effective speed is about the same, though certainly less distractive. Buses also are run on intermittent service, and, owing to overcrowding, all the stations, and all times of the day, is to reduce the effective "street-to-street" speed for a one-mile journey to $6\frac{2}{5}$ miles per hour; for a two-mile journey to slightly under 9 miles per hour; and for a three-mile journey to $10\frac{2}{5}$ miles per hour; even for a six-mile journey to only $12\frac{3}{5}$ miles per hour. Remembering that the vast majority of journeys taken is in the neighbourhood of two miles, and that it takes, say, six

* For journeys of one mile from "door to door" the effective speed averages only about $2\frac{3}{4}$ miles per hour, whether by tube or bus. Thus, by walking one can often go quicker and always save a penny.

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minutes to walk a quarter of a mile to and from the nearest tube station each way, the average Londoner gets about town at the rate of $4\frac{1}{2}$ miles per hour, if he uses the tubes. The effective service on the District and Metropolitan is somewhat better because they are shallow subways. Let us now similarly consider the effective "street-to-street" speeds *viâ* trams and buses. Their schedule speeds* are about 8 miles per hour in the central area. If we take two minutes as the average delay due to waiting, filling up, etc., the effect is to reduce the "street-to-street" speed on a one-mile journey to $6\frac{3}{10}$ miles per hour; a two-mile journey to $7\frac{1}{10}$ miles per hour, and a three-mile journey to $7\frac{3}{10}$ miles per hour. Allowing three minutes walking time at each end of a journey to and from the nearest tramway or bus station, we find the overall effective "door-to-door" speed for a two-mile journey to be $5\frac{1}{5}$ miles per hour. Thus, for the majority of Londoners taking short journeys about town, the surface facilities are about 15 per cent. superior to tubes in point of speed, and considerably better in point of mental wear and tear.

In the case of longer journeys, however, the tubes have the advantage, though not always, for if a journey involves an interchange between two tube systems, the buses often provide a superior service. Much may be said in condemnation of the comfortless and noisy travelling afforded by all the existing facilities, but there is some hope for improvement in this direction, especially as regards the bus services. There will, however, always be considerable annoyance and discomfort associated with all intermittent services.

In regard to fare rates, there is not much prospect of any material reduction from the prevailing rates,† which give the railways and tramways a very meagre profit. Still there are possibilities in this direction in the motor-buses, though the general public are not likely to reap any benefit. On the contrary, the continued growth and increased speed of motor-bus traffic, at least in the central area, can only be viewed with alarm, since the streets are already sufficiently dangerous and "delayous" to pedestrians. The casualty list*—about 367 fatal and 13,856 serious non-fatal accidents in the streets of London every year—is a bigger calamity than most earthquakes, but as it is so distributed it passes unnoticed. The future, however, *must* be viewed with alarm, if the only relief for the present congestion is to be secured by increasing the speed of vehicular traffic. This, it is supposed, will result when motors completely supplant horses. Fig. 3, however, shows how the tubes could greatly improve their effective speeds by adopting continuous elevators.

Let us now examine the inherent nature of city, urban, and suburban traffic. It is practically that of a continuous flowing stream, varying considerably in volume, at more or less definite periods of each business day—maximum density occurring at morning and evening, during what is known as the "rush hours."†

Usually the flow is along well-defined and regular channels, but periodically the traffic stream is diverted, and is often greatly augmented in volume according to special circumstances, which, however, unlike the weather, can generally be predicted with more or less certainty. The means for dealing with this human stream should consequently partake, so far as practicable, of a *continuous* as distinguished from an *intermittent* nature.

Passenger traffic is always demanding improved facilities, and every improvement is readily appreciated. Each new development is undoubtedly of benefit to the community, as also, generally speaking, to the whole of the previously existing systems, because of the growth of the travelling habit which is thereby encouraged. All existing facilities are being more and more severely taxed, by reason of the steady growth of the population, and expansion outwards towards the suburbs, with resulting increase, not only of the number of journeys per head of population, but also of the average length of journeys. Those engaged in the operation of transportation systems are endeavouring to meet the demand by intensifying their service. They are trying more and more to approach the condition of a

* See Sir Herbert Jekyll's 1911 Report. Table 18, Appendix F. iv. p. 154, gives average motor-bus speeds in central area taken in May, 1909, as 7·1 miles per hour. It may be taken that the speeds have somewhat increased since then, though in November, 1911, the schedule speed of motor-buses for the two-mile journey (twopenny fare) between Piccadilly Circus and Queen Victoria Street in seventeen minutes is still 7·1 miles per hour.

† See Table on pp. 120–121.

* See Sir Herbert Jekyll's 1911 Report, giving on page 76 the records for 1910. Compared with 1909, the fatal accidents increased 21 per cent., and non-fatal accidents about 6 per cent.

† This objectionable characteristic could be minimised by the provision of improved and cheaper facilities, encouraging ladies and other residents of the suburbs to come to the West End oftener. The effect of a late morning and early afternoon "rush hour" of shoppers and sightseers would be beneficial to all, and would considerably increase the mid-day traffic in the central area.

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continuous service, but they are severely baulked by the intermittent character of their systems, in some of which the commercially attainable limit has been reached.

Considering the serious inherent difficulties to be contended against, they are to be highly congratulated upon the remarkable results attained. Mr. Stanley and his able staff on the District Railway, in particular, deserve great credit and praise for their splendid work. Forty, and still more fifty, six-car trains per hour run on the District Railway, even though only over a short section, and during the rush hours this is a magnificent achievement.

Let us investigate this—*i.e.*, the absolute limit of the train system for a single track in each direction—a service far greater than can be attained in the New York subway, and beyond the capabilities of any of the London tubes. Without going into the details of operation to indicate the extravagancies involved in securing such a capacity, we may note that the capacity of 50 six fifty-seat-car trains per hour is 15,000 seats per hour. The duration of stops at stations for this service cannot appreciably exceed ten seconds, thus the time available for stepping in and out of the trains is only eight minutes twenty seconds per hour at each station. Obviously, therefore, the railway is available for only about 14 per cent. of the time, and but a comparatively small capacity can be handled from each station. Naturally this difficulty has to be overcome by filling the trains at a terminal, or at stations having island platforms—as suggested by Arnold, but of course such provisions considerably add to capital cost.

This is only one of the detrimental features of a periodic service. Now, the result of damming a human stream flowing at the rate of three miles per hour, if the volume is four abreast and six feet apart, and if the period of check is only one minute, consists in the accumulation of 176 people—meaning discomfort, and a serious time loss of more than one minute, because of the time required to enable this detachment to board the conveyance, pending the arrival of which it had accumulated. Obviously, if, instead of interrupting this human stream, accommodation could be provided with a capacity of about three seats per second passing through a station, at sufficiently slow speed to enable passengers to step on or off the cars, all the delay and congestion would be eliminated. There would neither be the need of a station platform nor of trains, long and large enough to accommodate the congestion. The facility would be available for 100 per cent. of the time, provided the seating capacity had not been already occupied at previous stations.

Now let us see what has been done to meet the requirements on these lines. So far only one system has been put forward and brought to a successful issue. That is the Multiple Speed Moving Platform. The author is indebted to Mr. Max E. Schmidt, President of the Continuous Transit Securities Co., of New York, for the following information regarding this arrangement.

The moving platform idea was proposed in 1872, but the first equipment was not operated until twenty-one years later, and then in a crude way at the Chicago Exhibition of 1893. Since then it has been worked in Berlin, and an extensive route of about three miles, built on improved lines, was installed in the Paris Exhibition of 1900. In the meantime the designs have been greatly improved and remodelled for city service. The slide shows an elevation, from which it will be seen that the system comprises three or more adjacent platforms, caused to move at three, six, and nine miles per hour respectively, by frictional contact of the tracks which they carry, and which rest on pulleys of diameter proportioned to give the desired relative speeds, mounted on a cross shaft and driven by electric motors. Supporting shafts are spaced 3 ft. 9 ins. apart, and driving shafts with motors are located every 202 ft. 6 ins. along route. The power consumption is remarkably low *—about 150 horse-power has been found sufficient to keep 900 tons of loaded platform running at six miles per hour. This system possesses extraordinary advantages over the train system, particularly in point of capacity, effective speed and low operating cost. It has proved beyond question the feasibility of continuous transit in public service by carrying without accident at least twelve million public passengers (each having had to make several speed changes) of all classes and nationalities. This is supported by the Public Service Authorities of New York State, who have approved and authorised its adoption. In fact, it may be safely stated that the list of those engineers and experts prominent in handling the practical end of the transportation problem, who have endorsed and approved the system, comprises as strong an aggregation of talent as has ever studied a similar problem.

The slides exhibited show in plan and in elevation a big installation contemplated in New

* See Hobart's "Electric Trains," p. 24.

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York. One slide represents the equipment pictorially. It will be seen that four platforms are proposed, the maximum speed platform being run at twelve miles per hour, and having seating accommodation thereon—a capacity of 73,500 seats per hour can be secured—*i.e.*, three times the seating capacity of the New York four-track subway when run at maximum service, with which it also compares favourably in point of effective speed. That eminent authority on the transit problem, Mr. Bion J. Arnold, recognising the limitations of the train system, and the advantages of the continuous plan, has in his recent reports directed serious attention to the moving platform proposition.

It may be here asked, Why is it that the moving platform has not yet come into general public service? The advantages of continuous conveyors and processes have long been recognised in the industrial world. Indeed, continuous lifts have been in passenger service in London for thirty years, and the moving stairway and other continuous devices have been at work for quite ten years. Why is it, then, that the continuous method has not been applied in the sphere of rapid transit?

The author feels sure that it is not because the negotiation of platforms or vehicles "walking" at the rate of three miles per hour is not feasible for public service. He believes that if Sprague had not introduced the multiple unit system of train operation about the same time that the moving platform was installed and run so successfully in Paris in 1900, the continuous system would have been by now commonplace. As it was, however, the "locoless" train became the fashion—and, by the way, there is too much "fashion" in engineering work. Still, the moving platform scheme, though extremely simple, and advantageous in many ways, is obviously too cumbersome and costly, especially in respect of the space and constructional accommodation it requires. In some respects it is even too capacious. Then, again, it necessitates eight negotiations of three miles per hour speed change for passengers to get up to and down from a maximum speed of only twelve miles per hour. It really is but a rather awkward attempt to get over the limiting feature of all other existing continuous systems—viz., the uniform and necessarily low speed, which alone has barred their progress. They do not fully meet the requirements of the ideal long sought and recognised to be a system which is:—

(1) *Continuous* in motion, so that the journey may be commenced immediately upon arrival at the starting place, to avoid crowding, consequent discomfort and delay.

(2) *Speedy* in action, so that distances may be traversed in the shortest possible time. Consequently, as of necessity the speed must be relatively slow at stations, so that passengers can readily mount and dismount, it must be capable of acceleration and deceleration between a minimum speed at stations and a maximum speed *en route*.

Furthermore, these requirements must be met with due regard to and adequate provision for:—

(*a*) Convenience, comfort and safety to passengers.

(*b*) Reliability, simplicity, and compactness with accessibility.

(*c*) Low initial cost in equipment and constructional accommodation.

(*d*) Low operating cost in power, attendance, maintenance and general charges.

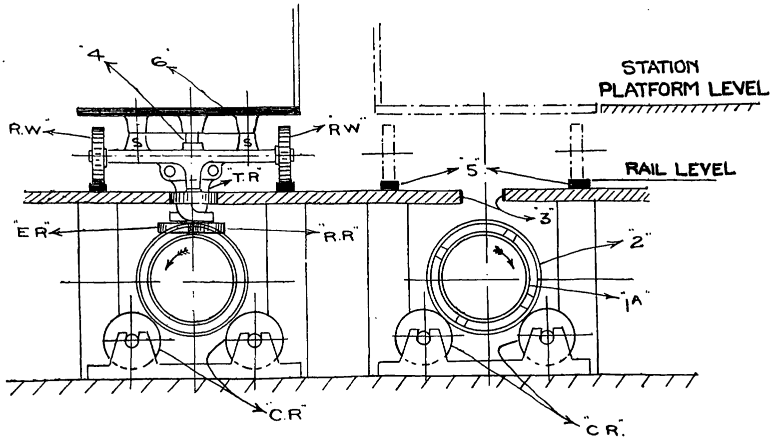

FIG. 4A.—DIAGRAMMATIC CROSS-SECTIONAL ELEVATION OF ADKINS-LEWIS SYSTEM.

NOTE.—The up and down tracks are placed close together, the cars running back to back, their floors being flush with platform level.

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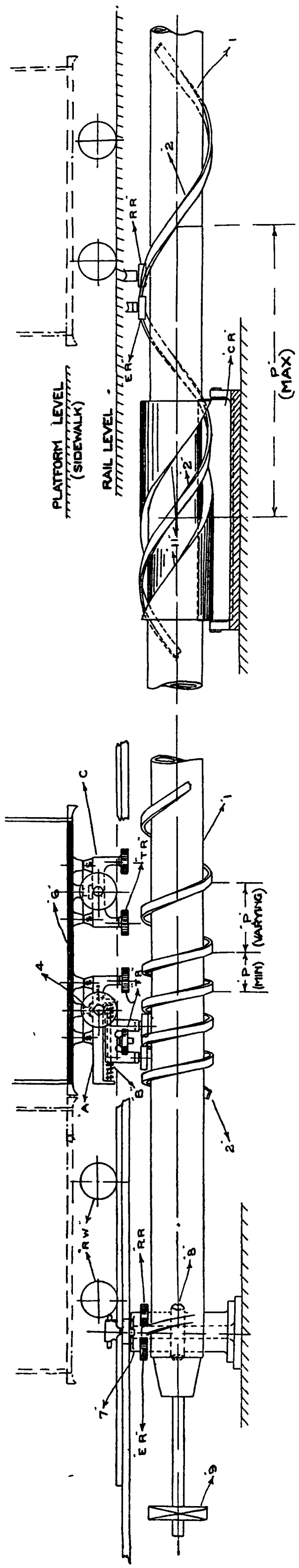

FIG. 4B.—DIAGRAMMATIC SIDE ELEVATION OF ADKINS-LEWIS SYSTEM.

NOTE.—Cars in close proximity to each other when engaged at minimum pitch portions of driving shafts (left-hand illustration).

Measured by this standard, neither the moving platform nor any other existing device can be claimed to comply with the requirements for their respective duties. The author will, however, now deal with the Adkins-Lewis system, which he submits as capable of fully meeting the essentials (1) and (2), and with handsome and amply adequate regard to the conditions enumerated (*a*), (*b*), (*c*), (*d*). It should be here mentioned that this system is capable of numerous applications, such as vertical and inclined elevators and combinations thereof for both passengers and freight—also to transporters for mails, parcels and almost any class of goods and materials either on the fully continuous, semi-continuous, or even the intermittent plan. The application which will now be considered is that for city passenger service over routes of any length, profile and curvature, in more or less shallow subways.

Referring to Fig. 4, diagrammatically representing the arrangement, it will be seen that the driving means employed comprise a spiral threaded shaft, "L," which is rotated at constant speed. Engaging with the spiral thread "2," are rollers "ER" and "RR" mounted with spring connection "B" to the under side of the leading truck, "A." The running wheels are flangeless and roll along the tracks "S." The leading and trailing trucks are designated respectively "A" and "C." Upon these trucks is mounted the car-body "6," through the medium of springs "S." The trucks are also provided with guide-rollers "TR," rigidly fixed thereto, and located centrally between the running tracks "5." These guide-rollers "TR" run in a chase forming side-tracks "3," to resist the side-thrust occasioned by the angularity of the spiral-thread drive, and to guide the trucks (which swivel under the car-body "6" about the pins "4") *en route* and around the ends "Z." Here the reverser "7," driven by the worm and wheel "S," suitably connected with the driving shafts by means of gearing "9," meshes with the projecting shank of the leading guide-roller "TR" before the engaging roller reaches the last thread convolution of the shaft by which it has been driven. The reverser "7" thus takes the car around the ends and serves to put the "ER" into correct engagement with the first convolution of the thread upon the other shaft for the return journey. The driving shafts are carried at suitable intervals upon cradle rollers "CR," forming bearings of the well-known "anti-friction" type. At the places where these cradle-rollers are located, a

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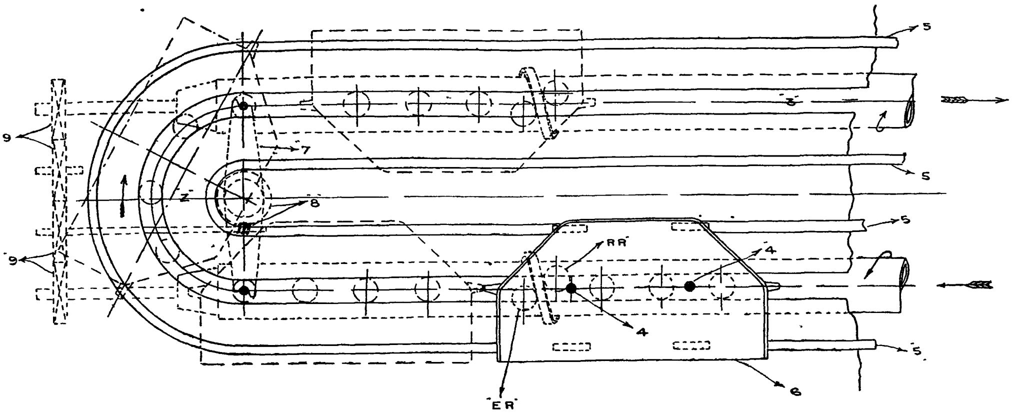

FIG. 4C.—DIAGRAMMATIC PLAN OF ADKINS-LEWIS SYSTEM.

NOTE.—The end of the route is shown, to illustrate how the cars are taken out of engagement with the last thread on the one shaft and put into correct engagement with the first thread of other shaft by means of the reverser, which also propels the cars around the short radius end curve.

muff or boss "10" is mounted. This muff or boss is slightly larger than the outside diameter of the screw thread, and is provided with a spiral groove "11" on either side of the thread "2," so as to permit the passage of the engaging and retarding rollers "ER" and "RR." The length of the muff or boss "10," and of the cradle-rollers "CR," is proportioned to be sufficient to ensure an adequate bearing.

As the driving shafts are rotated at constant speed, it follows that the speed imparted to the cars engaging therewith will be proportional to the pitch of the thread. For traversing stations the pitch and thread angle is low (approximately 8°), and provides a uniform slow speed. But, in order to provide a high speed *en route* between stations, the pitch and angularity is steep—namely, 45° (or even as much as 53°). The change from low to high pitch, and *vice versa*, to provide acceleration and deceleration, is *gradually* increased or decreased, as the case may be. Herein lies the outstanding feature of the system, and this is further dealt with in connection with efficiency, return of energy to line, and acceleration, later on in this paper, but more particularly in the author's British Association paper.

The cars are always engaged on an equal number of threads apart, irrespective of the pitch; the number of minimum pitch-threads being so selected as practically to equal the overall length of one car. The obvious result of this is that peculiar advantages are secured, viz., that the cars congregate in close formation at the stations, and that they space out to considerable distance apart when at high speed *en route* between the stations, so that, compared with any system of uniform speed platform, it is clear that very

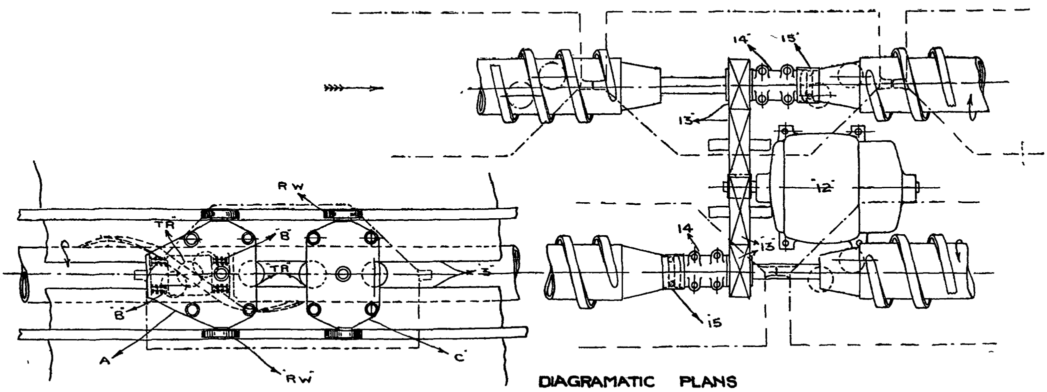

FIG. 4D.—DIAGRAMMATIC PLAN OF ADKINS-LEWIS SYSTEM.

NOTE that where cars are in close proximity to each other, as at stations, a gap is made in the spirals, which permits of the insertion of driving motors, thrust bearings, etc.

much less rolling-stock is required by this system. The close formation of the cars at the stations permits convenient means for introducing adequate provision for applying the motive power to the driving shaft, and also taking care of the end-thrust* due to the reaction of the cars, propelled by the spirally-threaded driving shafts. Referring to Fig. 4, it will be seen that if the overall length of the cars is made practically equal to the number of minimum pitches between adjacent engagements, the cars will just touch each other. Obviously, then, a gap in the spiral can be made at the close-pitch section, and this gap provides for the reception of the driving motor "12" and the bearing "14," with which is incorporated the thrust-ring "15." Clearly, the cars will be pushed over the gap by those following, thus ensuring correct engagement with the recommencing thread on the other side thereof.

The motive power is applied to the driving shafts on both routes simultaneously by the introduction of gearing "13" cross-connecting them, and taking the motor drive at the centre between tracks as shown. Similarly, as will be shown later, curves and changes of grade can be negotiated by introducing bevel gears which enable any length of driving shaft to be set at any angle with the adjacent length. In this case, also, advantage is taken of the gap in the thread to insert bearings and thrusts. Since the cars are absolutely controlled and regulated automatically by the engaging rollers "ER" and "RR" respectively, operating on the leading and trailing sides of the thread "2," and coming into action respectively at periods of acceleration and deceleration, there is no necessity of any braking and signalling system, such as are all-essential with the train system. Furthermore, there is no necessity to employ drivers and train conductors, nor for the numerous skilled and unskilled attendants connected with the train system at sub-stations and power-house.

Reference to Fig. 5, which represents for the purpose of comparison the layout of electrical equipment and power supply for the two respective systems, clearly indicates that most of the costly adjuncts inseparable from electric traction are entirely dispensed with in the "Adkins-Lewis" system. The provision of electricity for driving the shafting may, as

* The end-thrust is not of serious amount, since the reaction due to accelerating cars is largely counterbalanced by decelerating cars.

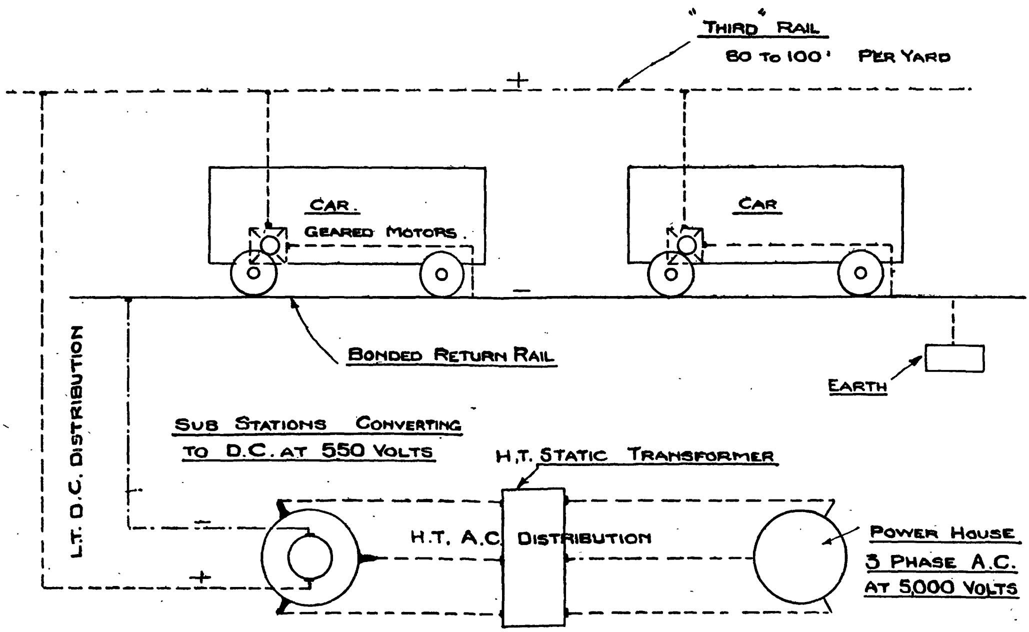

FIG. 5A.—DIAGRAM OF ELECTRIC TRAIN SYSTEMS. EQUIPMENT AND LAY-OUT OF POWER, PLANT, AND DISTRIBUTING ARRANGEMENT.

N.B.—The overall efficiency—power-house to car-wheels—is 51% *only*, and the energy consumption per seat-mile is 50 to 60 watt-hours for 16 miles per hour schedule speed, on route having two stations per mile.

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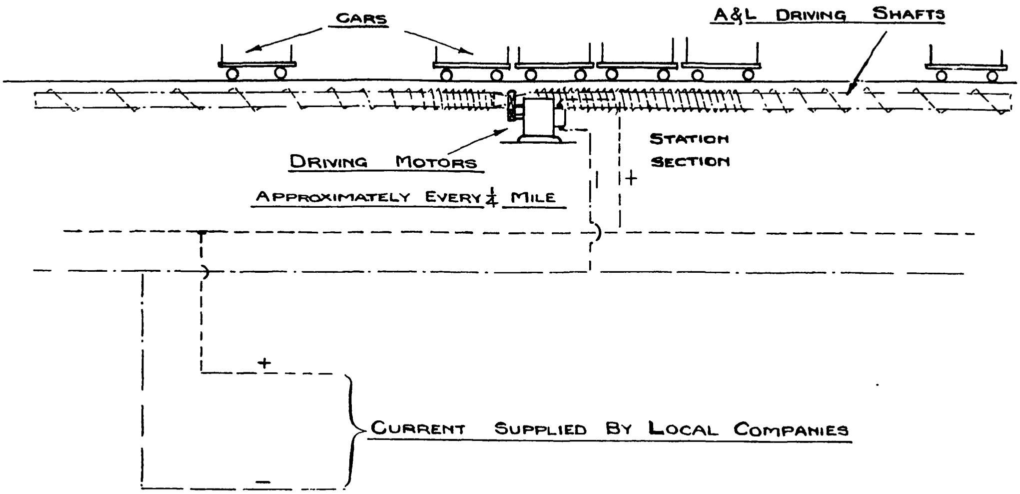

FIG. 5B.—DIAGRAM OF ADKINS-LEWIS SYSTEM—EQUIPMENT AND POWER SUPPLY.
Compare with Fig. 5A.

N.B.—The overall efficiency—power-house to car-wheels—is 70%, and the energy consumption per seat-mile is only 12 to 15 watt-hours for 16 miles per hour schedule speed, and *four* stations per mile.
The cars do not carry any driving motors and complicated control apparatus.
The spiral shafting is driven by electric motors located at quarter-mile intervals.

indicated, be entrusted to the local electricity supply companies through whose areas the route passes. The particular kind of current as regards pressure, or as regards whether it is continuous electricity or alternating electricity, is immaterial, as different kinds may be employed on different sections of the route. Thus the introduction of this system would enable those concerned in electricity supply undertakings to partake of a very acceptable load, the amount of which, though not large, would be practically constant for about eighteen hours of the day.

In order to give an idea of what the system would look like in actuality, a perspective sketch of the equipment in a tube is shown on the screen. Observe that the two tracks pass through one tube, that the cars pass back to back; and that in the station they are in close formation like a train. They are, however, whilst *en route*, widely separated from each other. Obviously, this is advantageous, and due to the original spacing of the cars an equal number of spirals apart, irrespective of the pitch, and to making the length of the cars equal to that number of times the minimum pitch—if they are required to touch each other—or slightly less in length, if they are not ever required to touch. When a car completes its progress at very slow speed through a station, it begins very gradually to increase its speed, and continues to accelerate to maximum speed with such perfect graduation that the speed change will be absolutely imperceptible to passengers.

Likewise with the deceleration on approach to the next station. The perfection of graduation attainable permits of high rates of speed change being employed. During these periods doors or gates, of the safety non-pinching type, will automatically close and open, remaining open whilst cars pass through stations and closed whilst *en route*. The station will always be full of cars, because when one is leaving, another is arriving at the other end. Notice that the track is invisible, as the cars are so close together, also that there is no room to get between them, and there is no train before which one could fall in front, even if some poor dejected passenger contemplated suicide. The side walks shown alongside the tracks between the stations are not for passengers' use, except in case of a complete stoppage, when, and only then, they would be available for exit to nearest station along the subway, which, as indicated, would be well lighted and white-tiled throughout.

The length of the station needs to be only 50 ft., or at most 75 ft. A car moving at three miles per hour would take seventeen seconds to pass through. Thus there would be eight seconds for passengers to step out of the cars during the passage of the first half of the station, and nine seconds for other passengers to step in during the passage through the other half of the platform. As a matter of fact, it does not require a

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second of time for even a slow-moving person to step over a line. Now it will be noticed that the car floor is flush with the platform level. Also that practically the whole side of the car is open for ingress and egress.

Here let us recall the District Railway's aggregate of 500 seconds' stop per hour at each station, and 15,000 seats per hour maximum capacity, remembering that there are eighteen doors available on each six-car train. If, then, 4,500 passengers wanted to step in and out of the trains per hour at each station they would have to "step lively" at the rate of one door per second. Moreover, both "in" and "out" going passengers would have to use the same doors and sections of platform at the same time. It could not be done. Even the spacious platforms could not accommodate the congestion. Of course it is more than is usually demanded.

But now let us see how such a traffic flow would be handled on the Adkins-Lewis system. There would be two streams, one going on through one half-length of the station and the other coming off using the other half-length of station. Each being of 4,500 passengers per hour would mean streams of seventy-five passengers per minute. If the walking speed be the usual three miles per hour, we should have each stream a single file of passengers each over a yard apart, or two abreast $2\frac{1}{3}$ yards apart. The "oncoming" stream would always be under check at the turnstile entrances to the station at street level, and would be controlled by the collector, who would regulate the flow according to the capacity available. The "off-coming" stream would have amply spacious exits and platform space. Now the carrying capacity of the equipment shown in the picture is 9,900 seats per hour, passing any point, plus 60 per cent. standing room, which may here be neglected. Thus, if there were 4,500 passengers riding through per hour, and 4,500 getting both on and off at each station per hour, there would still be 900 empty seats per hour passing through each station, or 5,400 seats available for the 4,500 passengers getting on. Designating the broad double opening in the side of each car as one "entrance," there would be available for each of the 4,500 "on-coming" passengers four entrance-seconds or one entrance for four seconds. Each passenger would have a choice of four cars extending for about twelve yards along platform. Similarly each "off-going" passenger would have one double exit for four seconds. Thus, even this heavy flow, which we found could not be negotiated by the District Railway, even with 50 per cent. more capacious service, could be handled quite conveniently by the "A & L" system. Of course it is far greater than would be usual in the case of a route having four stations per mile. For the conditions when the traffic-flow would be either all "on-coming" or "off-coming," the entire length of the station could be utilised, and at terminal stations, of course, the length and width of the stations would be suitably proportioned.

The point that the author wishes to emphasise is that by handling the passengers in *streams* instead of in *congregations* much greater capacity and comfort can be secured, and that accompanying these advantages are others even more important.

One of them is—owing to compactness, freedom from vibration, etc.—the accommodation need not be in the nature of deep tubes. Slide F shows pictorially the Adkins-Lewis equipment installed in a shallow subway. Thus access and egress between street pavements and the cars would be within a few seconds—say twenty or at most thirty seconds—including the time for paying the fare and passing through the turnstiles.* Now let us refer back to Fig. 3, which shows that with a total time loss of one minute, and a schedule speed of sixteen miles per hour, which the system provides when there are four stops per mile, the effective "street-to-street" speed for a one-mile journey would be $12\frac{1}{2}$ miles per hour, a two-mile journey $14\frac{1}{10}$ miles per hour, a three-mile trip $14\frac{3}{4}$ miles per hour—obviously, from 100 per cent. to 50 per cent. superior to those provided by tube railways for equivalent journeys (see Fig. 3). The average "getting about speed" would be still better, because there would be twice as many stations per mile consequently the walking time between any destination and the nearest sub-surface station would be only a matter of $2\frac{1}{2}$ minutes, instead of six minutes' walk on the average. The dotted lines in Fig. 1 give "door-to-door" speeds for various length journeys, *viâ* Adkins-Lewis shallow subways.

Referring to the author's articles on the traffic problem in the *Daily Chronicle*, wherein he stated that about thirty miles of such equipment would practically solve the problem, the wall map indicates the routes proposed. They need not now be discussed, though their effect would be

* By adopting turnstiles and uniform fare of one penny, the present ticket nuisance could be eliminated.

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very far-reaching.* The question is, "Does the Adkins-Lewis system render such facilities practical and possible, and if so are they desirable?" The author suggests that the Royal Commission's proposed "Traffic Authority" alone could determine the answer to the latter question, and, as to the former, he submits that not only is the continuous plan feasible for public service, but also that the Adkins-Lewis system is both mechanically and commercially sound, considered as means to attainments which cannot be reached in any other visible way. Let us consider the matter broadly.

One of the first points to consider is the possibility of tearing up the streets to construct in London, as in New York and elsewhere, shallow subways. Notwithstanding that the Royal Commission indicated affirmation, this may not be possible, but luckily such a procedure is unnecessary. The Adkins-Lewis system attains the ideal set up by that body—viz., "Stations *only* at or near the surface and the rest down low." All that it requires is a few basements under the pavements every quarter of a mile on alternate sides of the street. The rest, being at low level, could clear the obstructions, and by zigzagging diagonally across and along the streets, even easements for going under basement property can be largely avoided. This is because grades and curves can be very easily negotiated in the Adkins-Lewis system. Still the author would like to take this opportunity of urging the desirability of the Government conceding the Royal Commission's recommendation regarding procedure. It is in the interest of the community that way-leaves be granted under Royal Parks *free*, and under property upon payment for *structural damages only*. These privileges hold good already in the case of main sewers. Why not in the case of sub-surface railways? The resulting benefits would be relatively much greater.

Now consider some practical designs. First, the application to comparatively short transporters for interconnections and inclines up to about one in fifteen. The slide gives the general arrangement of such a transporter, which was prepared for, and, had there been sufficient time last spring, would have been installed at the Crystal Palace to carry passengers between the Low Level Station and the Palace Terrace. It is interesting to note that both Scotland Yard and the local authority, amongst others, approved the plans and sanctioned the equipment. The capacity of this is 4,500 standing passengers in each direction per hour, when the initial speed is only 1½ miles per hour. It should be here explained that the capacity is always proportional to the initial speed, and with a fixed ratio, the maximum and average speed is likewise governed by the speed of the driving shaft, which, of course, can be regulated by an electric motor over a very wide range. From the cross-section shown in the figure, it will be seen that the entire equipment of both tracks, including side walks, can be accommodated in a 10 ft. diameter tube. Thus ample capacity and speeds averaging about ten miles per hour can be compactly provided by the application of the system to feeders, and interconnections for existing underground railways, surface tramways, and similar services. For these purposes the equipment is very economical, both as regards initial and operating cost.

A representative design for a "tube" railway equipment is shown in the next slide, already shown pictorially. In this the cars provide five commodious seats and standing room for three extra passengers in each. Thus at the normal minimum speed of three miles per hour, the capacity is 9,900 seats per hour plus 60 per cent. standing capacity. The speed ratio is eight to one, so that the maximum speed is twenty-four miles per hour normally. Thus, if the distance between stations be one half-mile, as usual on the London tubes, the schedule speed of twenty miles per hour* would be provided. Obviously, in point of attractiveness, it is preferable to have twice as many stations per mile of route, viz., at 440 yards intervals, and in that case the schedule speed will be sixteen† miles per hour. This is at least as good, if not better, than the train system can maintain satisfactorily even with only two stops per mile.

It will be noticed that the entire equipment for this great capacity in each direction can be conveniently accommodated in a single 16 ft. diameter tube. Now bearing in mind the very much shorter stations, and the far less accommodation required at the route ends, terminal yards, cross-overs, etc., and considering the much lower capacity of a tube railway, it is obvious that the Adkins-Lewis system requires very much less constructional accommodation.

* See pamphlet containing reprint of these articles.

* This is 25 per cent. to 30 per cent. better than the train system can accomplish on routes having two stops per mile.

† The train system cannot maintain more than twelve miles per hour on a route having four stops per mile, and then only at such a high cost that such a service would be commercially impossible in London at present fare rates.

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Mere capacity, however, is not the correct basis of comparison between various systems. The earning power of a transit system, or at least its attractiveness, is a function of the number of seat-stops per hour that can be made at stations along a route. Designating this factor as "X," and figuring out "X" per square foot of property required, or "X" per £1,000 of capital cost, which is the more correct basis of comparison, it will be found that the Adkins-Lewis system possesses astounding advantages over the train system. Compared with the District Railway at maximum service, in point of the intensity to which it can use its tracks or clearance width for the passage of its trains, the Adkins-Lewis system will be found to be capable of subjecting its trackway to at least four times the intensity per unit area. This is a very important point, considering that the greater part of the outlay or the train system is represented by its tunnels, tracks, stations and similar items. Obviously the greater use to which this expensive property can be put, the less may be the fares and the greater will be the returns. Time does not permit of treating this and other interesting matters as fully as the author would like, so let us pass along to the question of capacity regulation.

It is recognised that if at the time of most dense* traffic, a railway has to pass, say, 12,000 seats, or 40 six-car trains per hour, the average for 365 eighteen-hour days will only be about 5,000 seats per hour. To meet this condition, the railways either increase the number of trains per hour or vary the make-up in cars, but the best they can do necessitates their running about three seat-miles per passenger mile secured in fares, and even this involves too much "straphanging" at times.

Now, varying the number of cars in service, more or less, in accordance with the demand, means that the annual mileage per car does not usually exceed forty or fifty thousand miles, and, whilst it is better to keep them idle than running around empty, it also means the provision of huge storage sheds at the terminal yard. Were it not that a large saving in wages of train crews and power consumption is thereby effected, it might be as well to keep the full complement of rolling-stock in service, since the increase in depreciation would be largely offset by the saving in car-sheds and the expenses attending the provision of the extra train crews, etc.

Let us here revert to the continuous system. The extra cost involved by keeping the full complement of cars in service, since they do not require train crews, and since they consume but little power, also since the depreciation and maintenance charges are so comparatively insignificant, does not warrant regulation of capacity to meet the demand by varying the amount of rolling-stock run. It can be done in a very much simpler way, by merely varying the speed. Thus on Sundays and slack periods of the day, a reduction of 25 per cent. in speed would still enable a schedule speed of twelve miles per hour to be maintained on a route having four stations per mile, and even this would be considerably better than existing services in point of effective speed, as shown in Figs. 1, 2, and 3.

Thus, upon the introduction of the continuous system, the very low speed of two miles per hour could be adopted and speeded up as the public became accustomed to it. In this connection, note that the capacity increases proportionately with the speed. Consequently, a route equipped with the Adkins-Lewis system could take care of traffic growth, within very wide range, because, when the initial speed becomes too high, subsidiary platforms could be installed at the stations to enable passengers to negotiate the cars in two stages on the lines of the multiple-speed moving platform previously described. The possibilities in this direction are worthy of note, but need not now be discussed.

Although smaller capacity would probably be found sufficient in many cases, let us consider the detailed designs for the greater capacity of 12,680 seats per hour with initial speed of three miles per hour, or 8,500 seats per hour with initial speed of two miles per hour, shown in the slide. In each case, the overload is 50 per cent. standing capacity. The complete two-track equipment with side walks requires only 17 ft. width in the clear and 13 ft. depth. A 16 ft. diameter, or at most a 17 ft. diameter, tube would be sufficient for runs between stations,* which would have 10 ft. wide platforms. The next slide indicates the general arrangement of details. The cars are eight-seated, their bodies being readily removable from the trucks, which are coupled by a yoke permitting each to take any curves by the guiding action of the thrust-rollers travelling in the central chase. The forward truck carries the double-

* See footnote † on second column of p. 107.

* The tracks need not necessarily be close together and accommodated in a single tube. They can be separated to any extent, so that each track could be accommodated in a small diameter tube, and two small tubes would be cheaper to build than one large one of the same area.

engaging rollers very substantially; the running wheels, which are flangeless, are retained on their tracks by the central guide and thrust-rollers. Derailment is obviated by the provision of a tilting check operating against the edge of the guide tracks. Here it should be stated that the slightest derangement causing this check to come into action would close electric circuits, which would cut off the power supply to driving motors and quickly bring the system to a stop. One form of automatic gate is shown at the car entrances. It will be seen from the plan and elevations that this is operated, through the medium of a spring to prevent pinching, by a very simple arrangement actuated by contact with a side track.

The next slide gives the details of one form of shaft construction. The method of building this in hexagonal form with standard rolled steel trough sections is a great improvement upon the tubular core shown in Fig. 4. It will be seen that distance pieces are inserted between the sections, and the whole is heavily riveted together. One end of these distance pieces is extended to carry and secure the spiral, and where the spiral pitch is close, three such fastenings per convolution, whilst six per convolution where the pitch is spread out, are found to be amply sufficient. The shafts are built up in lengths of 44 ft., and the joints are triple-scarfed as shown, bolted up by heavy turned bolts fitting drilled holes slightly oval to permit of expansion and contraction. In this connection it should be remembered that, as the temperature of subways does not vary more than 10° to 15° all the year round, the amount of expansion and contraction is extremely small, and can be satisfactorily provided for in the manner shown. The spiral consists of a stout rail or bar-section of more than ample strength. It is easily made to great accuracy by simply winding on a mandril in convenient lengths, which are fish-jointed together after mounting. The diameter of the shafts for the speeds required is 24 ins., when the spiral pitches vary from 12 ins. to 96 ins. Thus at 264 revolutions per minute constant shaft-speed, linear speeds of three and twenty-four miles per hour are given. The weight of the shafting complete, with bearing sleeves located about every 44 ft., carried in cradle roller bearings as shown, is about 110 lbs. per foot run. The cost per ton is obviously very moderate, as also is that for the entire equipment, including erection, seeing that all parts are light and portable, and largely repetition work.

Referring now to the next slide, we see how the rather sharp curve of about 70 ft. radius is negotiated. It has already been explained that where the spiral pitch is close the cars congregate together, and, if necessary, can be made actually to touch each other. Obviously, then, the spirals can be eliminated. The car engaged with the last few close pitch spirals on the one shaft will push the cars ahead of it over the gap and into correct engagement with the first spiral convolution on the next length of shafting. It does not matter if the gap comprises a straight run or a curve. The force necessary to push even a considerable number of cars around such a curve is a mere bagatelle, the speed being low and the track level. Although quite possible, the negotiation of curves at high-speed sections is unnecessary, because wherever a curve is necessary it would not be inconvenient to locate a station. Advantage is taken at such points to introduce the driving motors as shown—*i.e.*, at stations every quarter of a mile along the route—the shafts being enormously over-strong to transmit the power required without appreciable distortion.

Similarly, as indicated in the slide, changes of grade are negotiated. The diagram shows a station located at the top of a hill with a 5 per cent. grade on each side. The arrangement will be seen to comprise the simple application of a pair of conical gears interconnecting the driving shafts through the station gap by means of a horizontal length of ordinary plain shafting taking the driving motor, thrusts, etc.

The next slide shows two arrangements for negotiating the angle at the bottom of the grade. The actual coupling of the two shafts is effected by a pair of bevel gears. The thrust is transmitted through the centre by an ordinary spherical ball and cup, which is quite satisfactory considering the very small amount of oscillating movement existing. Now a little thought will reveal that if the driving shafts are so designed as to accelerate the cars down the grade, and to retard the cars going up the grade, the thrust due to car reaction can be practically balanced out. Still, even if this feature be neglected, the total thrust due to both car reaction and weight of shaft and cars on the incline would not be greater than could be adequately provided for by the simple means above described. But there is another provision, as shown in the slide, from which it will be seen that advantage may be taken of the gaping taking place on the bottom side of the thread, due to the angularity, to insert a thrust-bearing. Another point to be noticed is that although the ends of the spirals gape open on the bottom side of the revolution, they match

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up exactly on the top side where the engagement takes place. Thus, notwithstanding that at the point of change from inclined to horizontal shafts the speed will be at the maximum value, the engagement will have a continuous thread throughout. Although the joint in the spiral will not be fish-jointed at that point, the cantilever formed by the ends of the spiral will make the thread actually as strong as it is anywhere else, and the strength of the bar forming the spiral is always amply in excess of requirements.

proposition is before you, substantiate the claim that 80 per cent. of the kinetic energy would be returned to the system during deceleration on level tracks. The actual efficiencies of the driving device for various angularities are given in Fig. 6, the dotted curve giving the reversed efficiency. It will be observed that the efficiency in both directions is in the neighbourhood of 90 per cent., their product again indicating about 80 per cent. regeneration.

Now let us dip into the operating details.

Table. Efficiency of Varying Pitch Screw Driving Shafts

Position	Pitch	Angle "A"	Angle "ϕ"	Efficiency	Remarks	Formulae
Slow Speed	12″	9°·25″	1·10	89%	A = Angle of Thread	
Acceleration	12″ to 96″	9°·25″ to 52°·0″	1.10 1.10	89% to 95%	Average Efficiency 92%	$E = \frac{\tan A}{\tan(A+\phi)}$
High Speed	96″	52·0	1·10	95%	ϕ = Angle of Friction	
Retardation	96″ to 12″	52·0 to 9·25	1·10 1·10	95% to 87%	Average Efficiency 91%	$E_1 = \frac{\tan(A-\phi)}{\tan A}$
The return of Kinetic Energy to Shaft during Retardation = ·92 × ·91 = 83·75%						

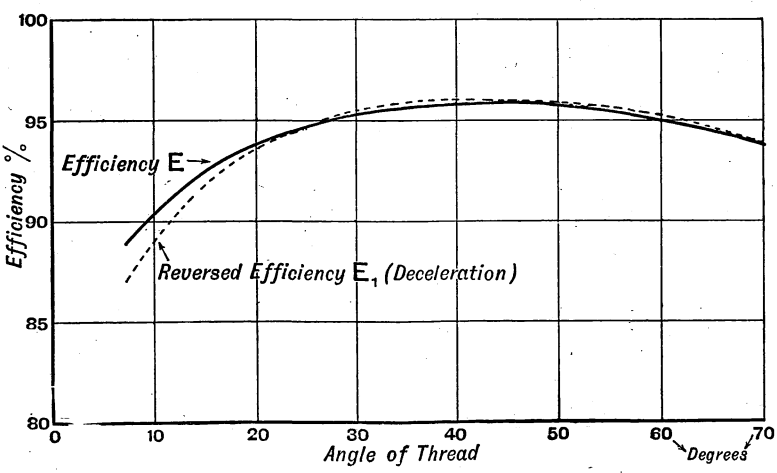

Fig. 6.—Efficiency of the Adkins-Lewis Driving System.

It is interesting to note the rather curious fact that the introduction of grades and curves on a route equipped with this system obviously tends to reduce the cost of the equipment. Grades also have the effect of minimising the forces necessary to produce acceleration and deceleration, and furthermore are clearly regenerative. Apart from the action of grades, however, the driving device is highly regenerative. Actual tests conducted at Ipswich by Mr. Hobart, whose general report* on the Adkins-Lewis

First, as to power consumption, lubrication, and maintenance of bearings. Any doubts as to the practicability of the Adkins-Lewis system on these points will be at once dispelled when the capabilities of ball and roller bearings are appreciated. These types of bearings have now reached such a stage of perfection and reliability that they can be absolutely depended upon when applied under proper conditions. It so happens that the conditions prevailing in this system are ideal for either ball or roller bearings. The loads and speeds are well within the limits. The

* See Appendix, p. 123.

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leading makers assure the author that these are much below their normal standards, and further that lubrication will be only a matter of charging the bearings with grease but once in six months, and, more important still, that the bearings will not begin to show any depreciation at all for the first ten years, since they can be made absolutely dust-proof. Ample evidence in actual practice can be furnished in support of these favourable prospects, but the author in his estimates makes very much more conservative allowances, even such as are appropriate to ordinary bearings. Yet, as can be shown, the results come out so favourably that his claims are fully justified.

As regards the power consumption, a quite simple calculation upon data very conservatively applied against the system when operated at a capacity of 12,672 fully loaded seats per hour, at a schedule speed of sixteen miles per hour on a route having four stations per mile, shows that only 200 kilowatts input per mile of track is sufficient to cover the total consumption for lighting, car propulsion, shaft rotation, and thrust, and all losses including the motors. Thus the energy per seat-mile would not exceed 15 watt-hours in ordinary practice. This is only about one-third of the amount found to be necessary in train practice, when there are but half as many stations per mile. Bearing in mind the uniform nature of the load, and the consequent lower cost of power per unit (especially if Diesel engines be used in its generation), the relatively greater amount of power consumed in brilliantly lighting the route throughout as proposed, does not vitiate the claim that, compared with electric trains, the Adkins-Lewis system can provide an equivalent service for less than a quarter of the power consumption per seat-mile, neglecting lift and other incidentals to tube railways altogether.

Time does not here permit of a detailed investigation of the operating cost, but seeing that the services of train drivers, conductors, signalmen and liftmen are entirely obviated, and further that both skilled and unskilled labour, superintendence and establishment, and all charges in general, are reduced to comparative insignificance, it is obvious that the gross operating expenses will be but a small fraction of those necessitated by the train system.

It is difficult to generalise in the matter of both capital and operating cost, but the table on pages 120–121 is given as a rough indication of results in comparison with various existing systems. Carefully-prepared estimates indicate that the capitalisation ought not to exceed one-half that of the more recent tube railways, on the same basis of composition: thus in the table £300,000 per route-mile is taken.* As regards gross operating expenses, the figure of 0·04*d.* per seat-mile appears to be well on the safe side. The table, which is self-explanatory, will, it is believed, clearly show that the Adkins-Lewis system is particularly well suited for the dense traffic usual in the central area of all great cities, and that it can do in many ways more than any existing system can ever hope to do.

It only remains to consider the question of wear and tear, the safety factor in component parts of the equipment, its general behaviour when at work, and lastly the feasibility of the continuous plan for public service.

First, then, as to wear and tear. Take the cars. Their dead weight is about 350 lbs. per seat; therefore there is only about one-third the amount of rolling-stock subject to depreciation that there is in the train system for equivalent schedule speeds and capacity. The car bodies are relatively quite as strong, but there is less vibration, and the stress coming upon them is decidedly less severe. Their trucks carry no complicated electrical equipment, nor is there the usual noisy air-compressor for the brake system, because no brakes are required. Thus the running wheels, which are flangeless and carry but light loads, will have a long life and will run easily. The whole car, including the automatic gate or door operating arrangement, is of the simplest possible character, substantial in construction, and with low centre of gravity —all tending to endurance and low initial and maintenance cost.

Now as to the tracks. The rolling loads are so light and well distributed that the usual heavy rails can be substituted by either a light steel bar section, or fibre or even rubber, set upon longitudinal timbers, thus securing comparative noiselessness. The central guide and thrust tracks are subject to practically insignificant loads, so that these parts do not appear likely to give any trouble.

Now we come to the wear and tear of the edges of the spiral and its pair of engaging rollers. Here it may be pointed out that the proper working of the engagement is not affected by slackness to almost any extent between the thread and its engaging rollers, and that there

* Note that the capacity taken is far greater than that of the tubes, and that there are four stations per mile as against two.

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TABLE OF COMPARISON

1	2	3	4	5	6	7	8	9	10	11	12	13
System.	Service.	Board of Trade coefficient of street obstructiveness.	No. of stations per mile run.	Schedule speed in miles per hour.	Street to Street speed. M.P.H. Average effective for 2-mile journey.	Capacity in seats per hour from terminal. Single track.	Overload capacity or standing room.	Gross cost per seat-mile. Pence.	Number of seat-miles run per passenger-mile secured in fares.	Gross cost per passenger-mile. Pence.	Fare rate per passenger-mile. Pence.	Net profit per passenger-mile. Pence.
Motor Buses. L.G.O.	Intermittent.	3	8	8	7·1	1,500	Nil.	0·2	2·5	0·5	0·55	0·05
Electric Trams. L.C.C.	Intermittent.	10	6	8	7	3,000	Nil.	0·15	3·5	0·525	0·525	Nil.
Electric Trains.	Intermittent.	0	2	16	8 to 9	12,000	50%	0·175	3	0·525	0·6	0·075
Adkins-Lewis.	Continuous.	0	4	16	14 to 15	12,680	50%	0·04	6 *	0·24	0·5 One penny fare for any distance.	0·26

This Table is put forward as a rough approximation only.

REMARKS AN

All interested in the London traffic problem and exponen

COLUMN 3.—See London Traffic Branch Report, 1910, page 6. The coefficients adopted have been criticised as unfair to tramways.

COLUMN 5.—The vast majority of journeys about London average two miles. In the central area the average is no doubt less. Tendency is towards shorter journeys, except in the case of rush-hour journeys to suburbs—increasing length.

COLUMN 6.—See Figs. 1, 2, and 3, and note effective speeds for journeys of one mile. "A & L" speed reduced 25 per cent. on Sundays a holidays, and slack periods of week days, the running time per day being taken at eighteen hours.

COLUMN 7.—See text. All present services are overcrowded during "rush-hours," and there is too much "straphanging" on railways. There could be no overcrowding nor straphanging on continuous system, as it is so capacious.

COLUMN 9.—The tendency is towards an increase in operating cost, especially in the case of trams. If in the train system the seat milea be increased two and a half times to correspond with the "A & L" system figures, the gross cost per seat-mile would be reduced about 0·123*d*., or about 30 per cent. The figure 0·04*d*. given for the Adkins-Lewis system might be considerably reduced.

COLUMN 10.—These figures vary according to class of route. * The allowance of six seat-miles per passenger-mile for "A & L" is high.

COLUMN 12.—The tendency is towards higher fare ratings on all railways. This is not conducive to general welfare.

COLUMN 13.—The future for L.C.C. tramways is decidedly bad. The prospect for the sub-surface railways is bright, whilst that for moto buses is still better, provided that increased street congestion will be tolerated.

COLUMN 14.—There are several routes in the heart of many large cities which would support a really first-class facility with returns of twel million one-penny fares per route-mile, especially if the unit fare covers any distance. Tubes lose most of the lucrative "short hau traffic to buses. † Tube's average fare per passenger is about 1·8*d*., indicating average length of journey of three miles.

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ETWEEN VARIOUS SYSTEMS.

14	15	16	17	18	19	20	21					22
Number of passengers, eraging journey of two miles, ecured in fares per route-mile per annum.	Net profit per route-mile available for dividends. £	Capitalisation per route-mile. £	Per-centage return on capital.	Number of seat-miles run per route-mile annually. Millions.	Length of Routes. Miles.	Average number of seat-stops per hour per route-mile for year (6,210 hrs.).	Relative Values. Features. Speeds.	Capacities.	Comfort. Reliability.	Economy.	General Efficiency.	Coefficient of custom attractive-ness and suitability for city service.
3,000,000 Average over all London.	1,250	17,500	7%	15	130	19,320	55	10	14	50	10	28
4,000,000 Average over all London.	Nil.	76,500 Double track.	Nil.	28	124	28,980	50	20	17	20	3	22
10,000,000 Certain tubes secure this mount of traffic over best ortions of route.	6,250	600,000	1% † See note to Col. 14.	60	8	20,600	50	85	24	10	50	44
12,000,000 With superior service and stations every uarter-mile, the custom would exceed this.	26,000 Low.	300,000 High.	8½% Low.	144	8	92,752	100	100	100	100	100	100

XPLANATIONS. *Attention should be confined to the dense traffic in central area.*

f the various systems are invited to criticise freely.

OLUMN 15.—Profits per route-mile may be considerably higher owing to slightly greater profits per passenger-mile than shown in Column 13.

OLUMN 16.—Figures given for trams and buses are too high for new concerns. L.C.C. and L.G.O. heavy capitalisation is due largely to previous animal-traction. The capitalisation of tubes was over-inflated, heavy parliamentary and incidental expenses for such facilities are detrimental to public benefit. Capitalisation given for continuous system should be ample on same basis as tubes. Smaller equipment would provide as good a service and be adequately capacious in many cases, so that superior returns could be made.

OLUMN 17.—Bus returns are based on L.G.O. figures for year ending September 1910. Trams on L.C.C. Report for year ending March, 1911.

OLUMN 18.—See note to Column 9. The bus companies can considerably reduce their operating cost by increasing bus mileage. The L.C.C. already work their tracks to an intensity far more severe than is usual, and apparently cannot increase mileage per track mile.

OLUMN 20.—See text. The number of seat-stops per hour per route-mile is a measure of the attractiveness of a facility.

OLUMN 21.—Values given have been assigned after consideration of following points to make a fair comparison of systems :—
Speeds=Schedule "Street to street" and "Door to door." See Figs. 1, 2, 3.
Capacity=Maximum rush-hour service, loading capacity per station, overload, average over 6,210 hours per annum and growth.
Comfort=Vibration, swaying, acceleration and deceleration, noise, ventilation, ticket troubles, protection from weather.
Reliability=Safety, freedom from delays, labour troubles.
Economy=Initial costs, operating cost, fares, return on investment.
Efficiency=Street obstructiveness, space requirements, flexibility, accessibility.

OLUMN 22.—The claim that the Adkins-Lewis system is only from two to four and a half times superior is very moderate.

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can be an ample margin of stock in the width of the spiral bar to cover any amount of wear that is likely to take place in many years. Consider the pressures that the spiral exerts against its engaging rollers, and *vice versa;* for the leading roller alone is engaged during the propulsion and the trailing roller only during retardation. The pressures are extremely small. Assuming the cars weigh two tons fully loaded and that the tractive effort is assumed at the high value of 10 lbs. per ton* on the level, it will be seen that for uniform speed sections, constituting about 70 per cent. of the track length, the pressure is only about 20 lbs., whilst for the remaining 30 per cent., comprising the acceleration and deceleration sections, this pressure is gradually increased and decreased in the case of level tracks to a maximum of possibly 1,000 lbs. Even this is not serious, and would be greatly minimised by the use of grades as previously indicated. Of course, an entire route may be graded all the way,† but the pressures would still be low.

In the consideration of these various points relating to wear and tear, it should be borne in mind that all the component parts are repetitions of but a few standards, and that naturally they would be made to gauge. All parts are readily "get-at-able." Even a length of shafting could be removed and replaced within a couple of hours, and there would be six hours every night and a longer period on Sundays for inspection and rectification, lubrication and cleaning.

The second item remaining to be dealt with is that of the safety factor. In this respect the system, as a whole, lends itself remarkably well in every detail to the provision of exceptionally high factors of safety without detriment in other directions. The chances of breakages of any parts are extremely remote, possibly more remote than is usual in railway practice. Yet flaws in metal parts are recognised to be possible—indeed, even inevitable. Then let us suppose that the obviously most vital part, viz., an engaging roller spindle, gave out. What would happen? It could drop on to the shaft, and then be very promptly thrown away to the side by centrifugal force, without doing damage, whilst the car would still be controlled by one roller. The free play it would have would only be 8 ft. at maximum pitch, so that no serious consequences would result. Such a breakage could be as safely guarded against as a broken axle on a railway train, and remember that electrical means could be provided to indicate the slightest derangement of any part. Perfection is not claimed for the system, nor are the designs shown in this paper either final or even the latest.

The third point relates to the behaviour of the system in working order. Of course this, as well as the two preceding points, can only be determined by actual trials upon a full-size equipment, but as regards the question of noise, it may reasonably be expected that, with "Citréon" gears, the cradle roller bearings suitably mounted, and other precautionary measures, noise will be practically eliminated. Anyhow, it will be far less than prevails in trains and trams. The riding of the cars will undoubtedly be far more free from vibration and swaying than in those cases. Ventilation and other considerations also can obviously be dealt with in satisfactory manner.

The author will close by referring to the feasibility of continuous transit. The question is not whether people can step on and off a moving way; no one doubts that anyone who can walk at all can step on and off a glacier, for instance—truly a moving way. The question is, What is the highest speed that can be negotiated by passengers who are agile enough to escape being killed by the present street traffic? Common-sense indicates that it is at least three miles per hour. Results from actual practice prove it beyond question. Necessity demands it, because there is no alternative way through the *impasse* which has been reached. Finally, it may be asked, Is it not worth a great effort to render possible the introduction of a system having such pronounced advantages? The author respectfully submits on behalf of his friend and associate, Mr. B. R. Adkins, who is equally responsible with him for devising the Adkins-Lewis system set forth, that it is. Both feel grateful to the Royal Society of Arts and to the audience for this opportunity of submitting the proposition; and to Messrs. Ransomes & Rapier, Ltd., for valuable assistance rendered in carrying out numerous and costly experiments and building a trial transporter nearly forty yards long, having a capacity of 2,000 to 3,000 passengers per hour and speeds up to ten miles per hour, from which valuable practical results have been obtained; also to Professor Dalby, Mr. Hobart, Captain Sankey, Mr. Basil Mott, Mr. David Hay, and to others who have kindly encouraged them.

* The tractive effort, including air resistance, is not likely to exceed 6 lbs. per ton on level tracks.

† The "up" track would be largely balanced by the "down" track.

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APPENDIX.

GENERAL REPORT ON THE ADKINS-LEWIS SYSTEM BY MR. H. M. HOBART, M.INST.C.E.,

Consulting Engineer to the General Electric Co. of New York.

OSWALDESTRE HOUSE,
NORFOLK STREET, STRAND, LONDON, W.C.
February 22nd, 1911.

Messrs. ADKINS AND LEWIS,
49, Queen Victoria Street, London, E.C.

DEAR SIRS,

Re THE "A & L" SYSTEM OF RAPID CONTINUOUS TRANSPORTATION.

During the last six months I have made a thorough examination of the propositions comprised in the "A & L" system of passenger transportation, and have made tests of the experimental machine at Messrs. Ransomes and Rapier's works at Ipswich. I have made investigations in which I have compared this system with the electric train system of passenger transportation as employed in tubes, subways and elevated roads in large cities.

As a consequence of my investigations, I am satisfied that the "A & L" system is based on thoroughly sound and practical principles, and that both as regards capital and operating costs, a specified result can be obtained much more cheaply than by the electric train system. While this is also the case for such long average runs as one mile between stations, the balance in favour of the "A & L" system becomes greater the more frequent the stops, until for such a case as an average distance of one-quarter of a mile between stations, while the "A & L" system can, with profit, operate such a service, providing a schedule speed of over fifteen miles per hour, this is commercially an impossibility with the electric train system, as with an average of four stops per mile, the highest practicable schedule speed which could be provided by the electric train system is twelve miles per hour, whilst the cost of providing such a service would exceed any return which could be obtained. With an average of three stops per mile, an electric train service begins to assume commercial practicability, but the capital cost is so great, and the return to the investor is so small (as also with only two stops per mile) that developments on these lines have during the last few years been practically at a standstill.

It is difficult to generalise in the matter, but the total capital investment for typical urban instances is, with the "A & L" system, very much less than the capital investment which would be required for an electric train system. The operating costs are also much lower with the "A & L" system than with the electric train system. The much lower initial and operating costs will permit of materially lower fares than are feasible by other methods of passenger transportation. This, together with immunity from delays, greater schedule speed and the features of comfort and safety attending the "A & L" system, should secure a large traffic to a route equipped on your system. The low costs and heavy traffic should yield an excellent return on the investment, notwithstanding the more moderate fares. With the electric train system, a reduction of fares below the present level would not increase the traffic sufficiently to increase the present unsatisfactory return on the investment, and higher fares would drive traffic to buses and trams in the streets.

Thus in the case of the roads already equipped with the electric train system there is no choice but to await the natural growth of the traffic. Although this natural growth is in several cases leading to a gradual slight improvement in the net earnings, there are certain cases where it is proving impossible to effect any improvement. Consequently although London's development requires an immediate large increase in rapid transit facilities, capital is not likely to be invested to any notable extent in electric train systems. There are also several large provincial cities which, whilst urgently needing rapid transit facilities, are unable to secure them owing to the enormous capital cost. My opinion is that in the "A & L" system these difficulties are very satisfactorily overcome, and although I have investigated the system very thoroughly I find no feature (other than faulty details associated with experimental machinery which are susceptible of obvious remedies) which should stand in the way of its practical and commercial success for the purpose of urban passenger transportation.

Amongst the fundamental principles contributing to the success of the "A & L" system, I attribute much importance to four valuable features, namely:—

1. The provision of a continuous succession of cars, moving slowly at stations and at high speed *en route* between stations. I am, after careful investigation, satisfied with the feasibility of the continuous principle in public service.

2. The perfection of acceleration secured owing to the graduation attainable in the driving system. This permits of attaining higher acceleration and deceleration, and with greater regard for the comfort of passengers, than is practicable with electric trains.

3. The excellent regenerative features of the system coming into operation during deceleration of the cars on approaching stations, whereby a large saving in power consumption is effected, and all braking devices with their attendant wear and tear are eliminated.

4. The elimination of the necessity for any signalling system, notwithstanding which, even greater safety is secured than is possible with the most comprehensive signalling systems yet developed for the control of electric trains.

Yours faithfully,
H. M. HOBART.

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DISCUSSION.

The Chairman (Captain Campbell Swinton), in opening the discussion, said that to him there was something extraordinarily fascinating in the idea that when a passenger wanted to travel from one part of a city to another he simply had to step down under the pavement and always find a means of transit waiting for him. About three years ago he put forward a proposal in an article in the *Nineteenth Century* of a method of transportation by means of a moving platform to cope with the difficulties of the traffic in the City. The City traffic required to be treated in an entirely different way from the rest of the traffic in London, as it was practically continuous for twelve hours in the day; and he proposed that a subterranean road should be made from, for instance, the Mansion House Station to Liverpool Street Station in the form of what he called a double-gourd, with a neck at the back. He did not know at the time how such a suggestion could be carried out, but the author had now put forward a proposal by means of which it could be done. The question that always arose, however, was whether people would use such a means of conveyance. Subways had been made at a great many places in London, but people would not go down into them unless they wanted to go to a railway. Then the question arose in his mind how such an automatic moving platform could be stopped. People would commit suicide, or they would get into dangerous positions; and in view of the fact that the author had stated that one of the advantages of his system was that very few officials would be required, it would be interesting to know how the service would be stopped if somebody threw himself underneath a car. The author seemed to suggest that some electrical appliance would ring a bell and that somebody somewhere would stop the system; but it appeared to him that there would be a very small chance of picking up many bits of the unfortunate person who happened to fall on the shaft. Another question he desired to ask the author was whether anything would be done to prevent a person who chose to pay his fare staying in the car for as long as he liked, and going round and round the circle. He was also informed by an engineer that there was a possible danger of the people who rode on such a railway being deafened by the noise. He had been on the London County Council for ten years, and had obtained a good deal of knowledge of the difficulty and cost of making tramways and subways in London. For instance, it cost at the rate of £37,000 per mile to lay the four tramway rails and two conduits, which only went down 2½ feet, in Theobald's Road. The author proposed to place his system underneath the pavement; but personally he remembered that when some years ago it was suggested that shallow trams should be made along the Strand it was pointed out that most of the houses in that thoroughfare possessed cellars underneath running almost to the middle of the street; and the County Council was informed that if a tramway was put there, according to the law at the present moment, if they bought the cellars they would be compelled to buy the houses as well. The inconvenience which would be caused while the system was being constructed was another difficulty. The London tubes had been made practically without people knowing anything about them, because they were right down in the London clay, and it was possible to construct them without incommoding anybody; but those who had watched Kingsway being constructed, and had seen the numerous kinds of pipes, tubes, sewers, and various other connections which had to be supported while the road was being made, and eventually put back again on the same level, knew the enormous difficulties that had to be dealt with. He was perfectly clear in his own mind that the proper place to install such a system was in a locality where an enormous number of people wanted to travel with the least possible trouble, such as, for instance, the City of London; and if the author could induce the Corporation to take up his scheme he might be able to make some progress. But the installation of such a system meant the spending of a great deal of money. The place in which it could be most easily installed at the lowest cost, was one of the London parks, but in that case probably there would not be sufficient traffic to make the railway a paying concern. For instance, right down Park Lane going to Victoria he doubted if there was sufficient traffic to make the construction of a railway a commercial proposition. Since the previous morning a new capital city had been born in the Empire, Delhi, where a new city was to be laid down on absolutely new lines. It would be an extraordinarily easy thing to lay down a system such as the author's in a new city, while it was an extraordinarily difficult thing to lay it down in an old city like London. The question was one very much of pounds, shillings and pence, and he sincerely trusted the author would find somebody who was prepared to put down sufficient money for the purpose of erecting a specimen system.

Captain H. Riall Sankey said that he had seen at the works of Messrs. Ransomes and Rapier the model transporter referred to by the author, which was about 60 ft. long, with bends at each end, and would carry 5,000 people per hour; and one of the most remarkable points in connection with that model installation was the enormous rate of acceleration attained, namely, 4½ ft. per second per second—just about three times greater than that attained on the District Railway. Notwithstanding that enormous acceleration, it was possible to stand up in the car without holding on to anything, and the passengers were not thrown down. The reason for that result was that the screw thread was perfectly developed on a proper curve, so that the acceleration was gradually increased and decreased. He also, while at Ipswich, took a few rough measurements, which satisfied him that the figure given by Mr. Hobart with regard to the return of

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energy was substantially correct; while he was also able to vouch for the accuracy of the other figures given by the author. One criticism frequently made against the use of such a transporter was that it was impossible for people to get in and out of cars moving at three miles an hour. He admitted that possibly 10 per cent. of the population could not do so; but it was not logical to argue that the remaining 90 per cent. of the population were to be debarred from using such a means of transportation for the sake of the minority. Another objection he had heard raised was that in the case of a family travelling on the author's system, the grandchildren would find themselves in one car and the grandparents in another.

Mr. Wilfred Stokes said that when the author first brought his system under his notice he treated it as a wild-cat scheme; but the more one studied the proposition the more one appreciated its charm. He did not think anybody could question that continuous transportation was much better than intermittent; and once the question was decided whether people could get in and out of a moving car, it seemed to him the system was so much better than train service that it should be given a trial. It might be said that a long, comparatively heavy screw revolving continuously was not a very fine mechanical contrivance compared with the present train service, but he thought it would be found on mature consideration that much more energy was wasted in the operation of driving an ordinary train than in keeping a screw revolving. He asked those present quietly to think over the scheme the author had brought forward, and he was sure they would come to the conclusion that there was a great deal more in it than appeared at first sight. In spite of the derogatory remarks that were made about motor-cars and flying machines in their early days they had become a great practical success, and he could not help thinking that the author's scheme would be successful in the same way. As an engineer, he expressed his great admiration for the ingenuity Mr. Lewis had displayed in solving many intricate problems.

Mr. Llewelyn B. Atkinson thought the system had now reached such a stage that nothing further could be done with it until it was given a practical trial. He had known Mr. Lewis for many years, and he felt sure that any scheme which he put forward would be worthy of the most careful consideration.

Mr. W. Mair, as an expert in connection with ball bearings and suchlike mechanism, assured those present that the author's figures with regard to the efficiency of roller bearings were absolutely correct. The manufacture of such bearings had been developed to such an extent in recent years that frictional loss was now practically a thing of the past. With a bearing made on the system designed by the author, there would be a saving of about 80 to 90 per cent. of the power used, as compared with any other kind of bearing.

Mr. R. P. Brousson said he thought, in justice to the existing methods of transport, it was not an unfair criticism to say that the author had emphasised the disadvantages of the existing systems. The author had not been quite fair in comparing his system with the present tube railways, because he assumed his system was placed in a shallow subway. There were great difficulties, however, in London in constructing such a subway, because of the pipes, wires, and cables that existed near the surface. A fairer basis of comparison would be to assume that the "A & L" system was a deep subway system. It was his own view that some form of moving platform or inclined elevator applied to the tube railways was becoming more and more essential, and it was only a question of time when the present lifts would be replaced by such contrivances; and when that day arrived a large amount of the delay which at present existed in getting in and out of the tubes would disappear. The author had assumed that the traffic stream was a uniform and a continuous one; but personally he considered that was a fundamental fallacy. The traffic in London railway stations was not continuous and uniform. For instance, at Finsbury Park, where the tube connected up with the Great Northern system, the officials were confronted with the problem of dealing, during the busy traffic hours of the morning, with batches of two hundred or three hundred passengers delivered on to the platforms in thirty seconds, and the author's system was at present incapable of dealing with such an aggregate of passengers without delay. For instance, at three miles an hour through the stations, he estimated that if the author had on his system about five seats available to every ten feet, his capacity would be about eight thousand seats per hour, and that was useless under present conditions, because one had to deal, not with an average, but with the maximum peak of traffic obtained not in an hour but in any five minutes. The maximum capacity of the electric train service on the District Railway was at present an eight-car train every 1¼ minutes, with an average speed of 16 miles per hour. It was an interesting point to compare the amount of track that was occupied in an ordinary electric train service with that occupied by the author's system. 23·7 per cent. of the track would be occupied by trains with the service he had just mentioned; whereas on the author's system, assuming the stations to be half a mile apart and the maximum speed 18 miles an hour, 27 per cent. of the track was occupied. It would therefore be seen there was not any great difference in the two capacities if his figures were fairly accurate. The author had assumed on his diagrams that he would have two seats side by side, whereas

on the present electric stock there were four seats transverse at a time, with the result that with the electric train service he had mentioned at least twice the carrying capacity could be obtained compared with that of the author's system. Immediately an attempt was made to get the same number of seats as in an ordinary train, it was necessary to have large tunnels, which meant that the cost would be very heavy if it was necessary to have a bigger capacity than at present existed. After all, the capacity of a system was the rate at which it was possible to load; and it would be found in all the London traffic systems that most of the passengers got in or out at one or two stations in the City area; and that it was necessary to provide facilities at those stations for loading or unloading almost the maximum capacity of the train: it could not be spread over a large number of stations. Turning to the question of mechanical details, while the author's system was certainly most ingenious, there was no flexibility in a moving platform beyond the question of varying speed. As the ratio of the traffic in the middle of the day compared with the morning and evening was 1 to 10, and very often 1 to 20, if the train was to be loaded to its proper capacity it would be necessary to reduce the speed ratio 1 to 20, which was impossible. Therefore there must be a large number of idle seats, because the peak load in an 18-hour traffic day was confined to 4 hours. For 14 hours the system ran at a comparatively light load, and with the present method of electric service it was possible to adapt the cars approximately to the number of passengers that had to be carried. Although he agreed that there probably would be a considerable gain in efficiency with the author's system, compared with the ordinary electric system, nevertheless, owing to the fact that the power consumption was constant through the traffic hours, the gain in power consumption would not be so great as was apparent. When a practical railway engineer first studied such a system as the author's he was alarmed at the thought of hot boxes, hot worms, car bearings, and so on; while it appeared to him there would be a tremendous rattle and din with the gears and roller clutches for propelling each car. The noise on the present tube railways was quite sufficient.

Mr. Yorath Lewis, in reply to the Chairman's criticisms, said it was practically impossible for a suicide to take place on his system of transportation, as it was impossible for anyone to get in front of a car; and there would be plenty of room in the cars for any loafers who wanted to ride round and round the circle. He was quite satisfied that the system would be practically silent. The gear, roller bearings, and ball bearings were silent; the cradle roller bearings might make a little noise, but it would be negligible. In comparison with a tube railway the noise would certainly be insignificant. With regard to the question of street obstructions, he knew "that numerous pipes, wires, and sewers" were underneath the streets of London; but, as he had shown in the plan, it was not proposed with his system to disturb the roadway. The stations could be accommodated under the pavements, which were mostly occupied by basements, and which could be bought very cheaply from property owners, because in most cases they would be only too glad, from a business point of view, to have a subway station on their premises. By grading to a lower level and curving, it would be possible easily to clear most of the obstructions. Personally, he thought there was a fine opening for the construction of the system he advocated between Piccadilly Circus and the City, and the Marble Arch and Victoria, as he was advised by well-known traffic authorities in London that there was a considerable flow of traffic between these two points. That view was supported by the fact that the London County Council had been agitating for a subway for its tramways along that route. The idea of installing the system in Delhi was a most delightful one. Mr. Brousson had stated that his comparisons were unfair to tube railways. As a matter of fact, Mr. Hobart had, over a period of six months, compared the "A & L" system with tube railways, and had reported against electric traction and in favour of the Adkins-Lewis system. With stations a quarter of a mile, half a mile, and even longer distances apart, higher schedule speeds at a very much lower cost were practicable than with the electric traction system; in fact, it was impossible for electric traction to operate a road having four stations to the mile at a schedule speed of more than 12 miles an hour, and then only at such a high operating cost that it was not a commercial proposition with present rates of fare. The new system scored very heavily over the electric train system in regard to capacity; while it was possible to work the tracks to at least four times the intensity of service on the electric system. It was only necessary also to have one-third the rolling-stock for the same schedule speeds and capacity. The system was more flexible in some respects than a train system. He disputed Mr. Brousson's contention that the District Railway were now able to run an eight-car train every 1¼ minutes. They could only do that when they adopted Arnold's suggestion of island platforms as the author explained in his British Association paper. Mr. Brousson would prefer a more direct comparison between the Adkins-Lewis and the train system, both in tubes. Well, here it was. Electric trains, two stations per mile: Schedule speed, fifteen to sixteen miles per hour; time loss as at present between street and trains, six minutes, resulting in effective street-to-street speed of about eight and a half miles per hour for two-mile journey. Adkins-Lewis system in tube of same depth, two stations per mile: Schedule speed, twenty miles per hour; time loss between street and trains, two minutes; resulting effective street-to-street speed, two-mile journey, fifteen miles per hour. As to capacity, the Great Northern and City

Railway, which Mr. Brousson managed, had two 16-feet diameter tunnels for a rush hour capacity of about 6,000 seats per hour, whilst the Adkins-Lewis system would require only one of the 16-feet tubes for both tracks to give a seating capacity of 12,680 seats per hour. Fig. 3 in the paper indicated how the tubes could benefit by using continuous elevators. Mr. Brousson was quite wrong in saying that the author assumed the traffic stream was uniform. Let him read the paper. He was thinking only of his Great Northern and City Railway, which was merely a short rush hour feeder between the City and Finsbury Park Junction. It lost the day traffic to the surface trams and buses running on top of it because they gave a superior service, though their schedule speeds were only one-half that of the tube trains. There were several routes in all large cities, however, such, for instance, as along Oxford Street and between Piccadilly Circus and the City, where the traffic stream was fairly uniform all day, and of exceptionally large volume. The streams of traffic were always continuous, and ought to be handled by continuous instead of intermittent methods. Mr. Brousson's mental estimates as to capacity of the "A & L" system were quite wrong. Five-seat cars each 8 feet long gave a capacity of 9,900 seats per hour—and 8-seat cars 10 feet long gave 12,680 seats per hour. Even the rushes of 200 or 300 passengers in thirty seconds he mentioned could be easily dealt with from an "A & L" terminal with the lower capacity equipment as shown in the paper, whilst with the train system such conditions involved very distressing results. He said, after all, the capacity of a system was the rate at which it was possible to load. Mr. Lewis quite agreed, and that was where the Adkins-Lewis system scored very heavily over the train system. As to the amount of track occupied by trains or cars, Mr. Brousson needed a little more education on this point. He seemed to overlook the fact that the higher the schedule speed, the less will be the amount of rolling-stock required, and the less will be the percentage of track occupied for the same capacity, and here again the Adkins-Lewis system scored heavily. Moreover, when the intensity to which the trackway or property can be worked by various systems was considered, it would be found that the Adkins-Lewis system can subject its property to at least four times the intensity per unit area. As to the practical details, Mr. Brousson apparently was not well experienced in mechanical engineering—at least, in respect of the capabilities of ball and roller bearings, which were capable of running continuously without any temperature rise. His fears on these points were absolutely groundless, as they also were regarding "rattle and din," for there were no clutches, whilst the gear would be absolutely silent.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Yorath Lewis for his paper, and the meeting terminated.

DURBAR HONOURS.

The following members of the Royal Society of Arts are among those who have received honours from the King on the occasion of His Majesty's visit to India, and in commemoration of the Coronation:—

K.C.S.I.

Maharajadhiraja Sir Bijay Chand Mahtab Bahadur, K.C.I.E., of Burdwan, a Member of the Council of the Lieutenant-Governor of Bengal for making Laws and Regulations.

Apcar Alexander Apcar, Esq., C.S.I., Consul for Siam in Calcutta.

G.C.I.E.

His Highness Maharaja Bhupindra Singh Mahindra Bahadur, Chief of Patiala State, Punjab.

K.C.I.E.

Lieutenant-General Sir Douglas Haig, K.C.V.O., C.B., Chief of the General Staff, Indian Army.

Rajendra Nath Mukharji, Esq., C.I.E., Sheriff of Calcutta.

Lieutenant-Colonel Percy Zachariah Cox, C.S.I., C.I.E., Indian Army, Political Resident in the Persian Gulf.

Francis Edward Spring, Esq., C.I.E., Public Works Department (retired), Chairman of the Madras Port Trust Board.

William Arthur Dring, Esq., C.I.E., Agent, East Indian Railway Company.

Raja Shaban Ali Khan, Khan Bahadur, of Salempur, Lucknow District, Oudh.

C.I.E.

George Cunningham Buchanan, Esq., Chairman and Chief Engineer of the Port Trust, Rangoon.

William Rucker Stikeman, Esq., Chairman of the Burma Chamber of Commerce.

Edward Robert Kaye Blenkinsop, Esq., Indian Civil Service, Commissioner of Settlements and Director of Land Records, Central Provinces.

John Ghest Cumming, Esq., Indian Civil Service, Secretary to the Government of Bengal.

Rai Sahib Diwan Amar Nath, Chief Minister to His Highness the Maharaja of Jammu and Kashmir.

Sardar Naoroji Pudamoji, ex-President of the Poona Municipality, Bombay Presidency.

Claude Alexander Barron, Esq., Indian Civil Service, Deputy Commissioner, Delhi.

Major Percy Molesworth Sykes, C.M.G., Consul-General and Agent to the Government of India in Khorasan.

G.C.V.O.

Lieutenant-Colonel Sir Arthur Henry McMahon, K.C.I.E., C.S.I., Secretary to the Government of India, Foreign Department.

KNIGHT BACHELOR.

Shapurji Burjorji Broacha, Esq., Sheriff of Bombay.

KAISAR-I-HIND MEDAL.

James Forrest Brunton, Chief Officer and Chief Engineer of the Karachi Municipality.

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OSTRICH FARMING IN GERMANY.

The Hagenbeck ostrich farm at Stellingen, near Hamburg, was founded three years ago, and is growing rapidly in importance as well as in size. It was the theory of the proprietor of this farm that the ostrich, although a native of tropical or hot countries, would thrive in colder localities, and as a result be stronger in health and grow a heavier crop of feathers. During the three years that the Stellingen farm has been in existence this theory has been proved to be correct, although, for reasons to be explained, the enterprise has not been, from a commercial point of view, particularly successful. In South Africa, and in other warm countries, feathers are plucked regularly at the end of every nine months, this being the usual time required for the bird to grow a new coat. In Hamburg, however, according to the American Consul-General there, owing to the cold weather, the feathers can be plucked only in the spring of the year, the birds being housed in the winter months except on sunshiny days, and always at night. During these housing periods the feathers become broken, and while they are still of value they are less so than feathers plucked in good condition at the right season. The Stellingen farm holds two South African (Cape) female birds, two each from Senegal and Somaliland, and eight from the Blue Nile country, the last being considered the finest birds, and a species becoming very rare. There are a hundred or more birds of ordinary qualities grown from the egg in Hamburg. It is the custom to breed a cock bird having long, narrow, and very short feathers with a hen bird whose feathers are very weak but short and wide. In addition to the farm at Stellingen, the proprietor possesses one in German West Africa, and a ground has been purchased for a large farm at Piranto, near Trieste, the climate of which is considered most favourable. It is the intention to bring feathers from these two latter farms to the one at Stellingen to be manufactured for the trade. Up to the present, were it not for the entrance fee to tho Stellingen farm as an exhibition, the venture would hardly be a paying one. The incubator is used for hatching at Stellingen, but the hen-setting method is considered by all experts to be preferable. This latter method is not practised in Hamburg owing to the climatic conditions. There is some difficulty in hatching the eggs by means of an incubator, and close attention must be paid to avoid a total loss for the shells of the eggs are so tough that the young ostrich is unable to free itself, and help must come at the right moment from without. It generally takes about nine weeks to hatch in the incubator. Another peculiarity of a baby ostrich is that it will not eat when alone, and at the Stellingen farm there is a large size ordinary duck of a common breed which acts as foster-mother to all the young birds when first hatched.

CULTIVATION OF THE TEASEL IN FRANCE.

The teasel—fuller's weed, or fuller's thistle, as it is sometimes called—is still cultivated in France, though not so largely as formerly. During the last fifty years the area cultivated in that country has diminished about one-third in extent. In 1862, 2,326 hectares (5,745 acres) were cultivated with this plant; in 1882 this was reduced to 1,887 hectares (4,660 acres), and in 1909 to only 1,529 hectares (3,776 acres).

The substitution of metallic cards in place of the "burrs" of the teasel heads formerly used in the process of "fulling," or raising the nap of cloth and other woollen material, may account in some measure for this decrease. It is found, however, that the natural "burrs" of the teasel are more suitable than their metallic substitutes for the manufacture of certain classes of goods. This tends to maintain a demand for the heads.

In France, the teasel is grown chiefly in three departments. The areas cultivated, production and values in 1909 are given in the table below.

The teasel is also cultivated, on a small scale, in the Departments of Aude, Basses-Alpes, and Eure, but the production there is too insignificant to take into account. The plant is biennial, growing very slowly the first year, and flowering the next, in May and June. It thrives best in a light, gravelly soil, with a southern aspect, and well drained. In a very rich soil, the heads are apt to grow too large, and to be not sufficiently elastic.

	Areas.		Weights.		Value.	
	Hectares.	Acres.	Quintals.	Cwts.	Francs.	£ Sterling.
Bouches-du-Rhône . .	991	2,447	14,850	29,230	891,900	35,676
Vaucluse	376	929	3,760	7,400	265,200	10,608
Seine-et-Oise	127	314	1,903	3,750	123,825	4,953
Totals . . .	1,494	3,690	20,513	40,380	1,280,925	51,237

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The seeds should be sown in the spring, and the young plants kept well thinned out. In August they should be transplanted into rows about 12 to 15 inches apart; beyond weeding they require but little attention during the first year. Sometimes they are sown, like clover, with some cereal crop, and after harvest the plants are left in place, and simply weeded and thinned out.

In the following spring, as soon as the plants show signs of vigorous growth, and attain a height of 50 or 60 centimetres (1 foot 8 inches to 2 feet), the side shoots require to be removed, and the number of flower stalks restricted to eight to twelve on each plant.

The harvesting should not commence until the leaves begin to fall, and from green turn to yellow; this generally takes place in August. As they ripen, the heads should be removed singly, leaving a stalk from 10 to 30 centimetres (4 to 12 inches) in length; they are then removed to a shed or loft for five or six days till completely dry. The heads require careful handling in order not to damage the points of the "burrs." When perfectly dry, they are carefully sorted and packed in boxes or parcels containing 25 to 100 heads of uniform size and colour, and then stacked in a dry place.

The stalks of the plants are rooted up and dried to serve as fuel, especially for heating baking ovens.

The heads of teasel are usually sent away in bales or baskets of suitable size; for export they are packed in light wooden crates, weighing from 150 to 200 kilogs each (3 to 4 cwt.).

The average yield, in soils of medium quality, is at the rate of about 10 quintals of heads per hectare (8 cwt. per acre). In the Departments of Bouches-du-Rhône and Seine-et-Oise, where the land is more fertile, a production of about 15 quintals per hectare (12 cwt. per acre), is obtained.

The teasel is subject to the attacks of various insect and fungoid enemies. Amongst the former is a caterpillar, which preys on the leaves and stalks of the plant from April till July, devouring the heads just as they appear. For this pest there appears to be no remedy. Amongst the vegetable parasites are a fungus, the *panispera diapsis*, which also attacks other plants. For this, various chemical solutions have been used with some degree of success.

THE WHEAT HARVEST IN FRANCE.

The following estimate of this year's production of wheat in France has just been published by the Minister of Agriculture. The figures are based on the official returns from the ten regions or agricultural districts into which the country is divided.

This total production of 110,722,500 hectolitres (304,486,875 bushels), or 87,128,300 quintals (171,512,400 cwt.), works out at the average rate of 19½ bushels, or about 13¾ cwt. per acre for the whole of France.

As compared with the harvest of last year (1910), which amounted to 68,806,100 quintals (135,445,078 cwt.), that of the present year shows an increase of 18,322,200 quintals (36,067,322 cwt.).

Taking into account the 1½ million of foreign wheat in stock at the end of last month, and that remaining from last year's harvest, it is estimated that the quantity now existing in France will be sufficient to meet all the requirements of the population.

Regions.	Areas in		Production in	
	Hectares.*	English Acres.	Hectolitres.†	English Bushels.
1. North-West	676,700	1,671,449	11,220,000	30,855,000
2. North	1,145,050	2,828,274	30,708,100	84,447,275
3. North-East	513,500	1,268,345	9,664,900	26,578,475
4. West	1,032,300	2,549,781	16,486,600	45,338,150
5. Centre	769,000	1,899,430	13,229,400	36,380,850
6. East	697,200	1,722,084	10,912,800	30,010,200
7. South-West	694,800	1,716,156	7,678,200	21,115,050
8. South	403,700	997,139	5,503,600	15,134,900
9. South-East	374,800	925,756	5,124,500	14,092,375
10. Corsica	24,300	60,021	194,400	534,600
Totals	6,331,350	15,638,435	110,722,500	304,486,875

* Hectare = 2·47 English acres. † Hectolitre = 2¾ English bushels.

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HOME INDUSTRIES.

Coal-miners and the Minimum Wage. — The meeting of the Conciliation Board for the federated mining districts in England and North Wales last week, to consider the question of a minimum wage, was not able to arrive at an agreement, but other meetings are to be held shortly, which, it is to be hoped, will settle this knotty problem. The owners' representatives on the English Conciliation Board had agreed to recommend a minimum wage to their districts, but it is doubtful whether the mass of the owners are as yet prepared to support them. It is not so much the abnormal place that is the difficulty with employers as the abnormal man. The demand of a section of the men is for a minimum wage for every coal-hewer, absolutely independent of any other circumstance than his descending the pit to do a day's work. The contention of the coal owners is that there are a large number of men employed who, by reason of age, physical unfitness, or lack of skill, produce regularly less than an average day's output of coal, and that if a minimum wage were fixed on the average wage of the district, then provision would have to be made for these workmen, or the employers would have to discharge all those whose output of coal fell below the average. This was the objection raised by the Lancashire coal owners at the joint meeting held in Manchester on November 8th. They offer to set up machinery to investigate every case where a workman fails to earn the average wage, and if this failure is proved to be due to faults in the coal seam, to hard coal or stone, or to any cause for which the management is responsible, they will pay the workman the average minimum wages of the district, but the owners object to the payment of the minimum wage when the failure to earn the average wage is due to some abnormality on the part of the workman. It is also pointed out that the concession of the extreme demand of the men would mean an entirely new method of payment for coal-hewers, instead of as now by contract, the wages depending upon the quantity of coal that the workman sends to the surface. It would mean the abandonment of the whole system of payment by results, and it is only by that system, as the owners contend, that they can regulate output without excessive supervision. Moreover, some colliers, to whom the piece-work system means high wages, are also against changing it. The offer now made by the owners may be defined as willingness to pay the average day's wage where there is proof of a fair day's work, and this surely should form a basis for a working arrangement between masters and men.

Manchester and Persian Trade.—Whatever may be the merits of the dispute between Russia and Persia, there can be no doubt as to the desire of Manchester that the territorial integrity of Persia shall be maintained. The present anarchical condition of affairs in Persia is very inimical to British trade, and if it were followed by partition of the country between England and Russia, things would go from bad to worse from the British trade point of view. The north-eastern provinces of Persia, which would go to Russia, are of enormously greater industrial value than the arid districts of the south, which would fall to England, and Russia with her rigid protection might be relied upon to put all possible barriers in the way of British trade. This is a view which, in the opinion of Manchester shipping houses, has not been sufficiently considered by the British Government.

Damp in Cotton.—Spinners have been trying for a long time to secure some amendment in the clause of raw cotton contracts referring to damp in cotton, and there has been another conference in Liverpool between representatives of the Federation of Master Cotton Spinners' Associations and the directors of the Liverpool Cotton Association. The spinners suggest that some test of a scientific character should be taken before arbitration proceedings begin, and that the arbitrator should take notice of such evidence. The directors of the Liverpool Cotton Association are considering the suggestion, and it is not unlikely that they will shortly consult their members upon the point.

Italy and Cotton Yarns.—According to Mr. Clive Bailey, British Consul at Warsaw, large quantities of cotton yarns are being imported into Poland from Italy to the detriment of the interests of local and British spinners. This importation is due not to any general extension of the foreign trade of Lodz, but to the depression of the cotton industry in Italy, where the warehouses are said to be full owing to over-production. The import of cotton yarns into Lodz is restricted to the higher counts, but the weaving industry of the neighbourhood does not appear to have benefited much by the opportunity of obtaining yarn at low prices.

The Insurance Bill.—The Insurance Bill having passed the House of Commons, it is not expected that it will be rejected by the House of Lords, so that in all probability it will be the law of the land and in operation as from July 1st, 1912. At a time when most men were speaking well of it, reasons were given in these Notes for questioning many of its provisions, and as a result of critical examination there are grave doubts as to its successful working. Many who are not extremists consider it a crude, unfair, and dangerous measure, but we must all hope that it will work better than many who would like to be its friends predict. However that may be, there is much in Sir Charles Macara's contention that the composition of Parliament has rendered it necessary that no great economic measure should be introduced without previous consultation with the most experienced men, representing both capital and labour, engaged in the great industries upon which our national existence depends.

Exports and Imports.—Whether Sir C. Macara is right in his view of the Insurance Bill must be

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left to time to decide, but the Board of Trade returns just published afford abundant evidence, if that were needed, of the truth of his contention that the cotton industry is of enormous importance to the country. The increase in imports for the eleven months ended November 30th is over £6,300,000, and the increase in exports over £22,500,000, in comparison with the corresponding months of 1910. In the making of this record the cotton industry has had more than a proportionate share. The imports of raw cotton increased by nearly £6,000,000, and the exports of yarns and fabrics by £14,660,000, so that nearly the whole increase in imports and two-thirds of the increase in exports are due to the cotton industry. The growth in the value of the exports of cotton during the last three years has been remarkable. Taking for each year the eleven months ended November 30th, the figures are: 1909, £85,220,000; 1910, £96,023,000; 1911, £110,683,000.

Post Office Grievances.—The rumour that a postal strike will probably take place at Christmas is hardly likely to be verified by the event. The Postmaster-General has already intimated that the desired inquiry will be held in 1913, and a parliamentary paper has just been issued which shows how greatly the position of some of the post office men, in the matter of wages, has improved during the last quarter of a century. Comparing 1885 with 1910, the official figures show that the wages of male sorters have improved from 28*s.* 5*d.* to 50*s.* 7*d.*; of C.T.O. telegraphists (male), from 28*s.* 10*d.* to 50*s.* 10*d.*; of C.T.O. telegraphists (female), from 22*s.* 10*d.* to 29*s.* 8*d.*; of counter clerks and telegraphists (male), from 34*s.* 5*d.* to 49*s.*, and of counter clerks and telegraphists (female), from 21*s.* 11*d.* to 31*s.* 9*d.* These figures represent the average payment in each class, and go far beyond any rise in the cost of living. They are not, of course, an answer to the complaints of pensioners, temporary hands, and others, who say they are sweated; but they show at any rate that a good deal has been done to improve the position of Post Office employees in recent years.

The Shop Hours Bill.—The Shop Hours Bill has passed the House of Commons, but it has been much mauled in the passage. Under pressure of time, the Government has had to drop the main provision of the Bill, which limited the weekly hours that a shop assistant might work to sixty. This provision, which many considered the most important in the Bill, was debated in the Standing Committee, and was very generally supported, not only in the House, but in the country, but on the ground that it was contentious the Government dropped it. If it had been passed it would, allowing for the weekly half-holiday, have set up something like an eleven-hour day, and left the shopkeepers free to make with the assistants any arrangements which suited them and their customers. As it is, the assistants gain: (1) a weekly half-holiday; (2) three-quarters of an hour for dinner, or an hour if they have to go outside for it; (3) half-an-hour for tea; (4) a compulsory break after six hours' work. The Home Office is also to do what it can in the way of initiating and promoting early closing arrangements.

The Prudential Assurance Company.—The death of Sir Henry Harben, at the great age of eighty-eight, recalls the history of what is perhaps the most remarkable insurance business in the world. It was Mr. Henry Harben who in 1848 founded the Prudential in Ludgate Hill, near La Belle Sauvage Yard, with a capital of £2,500, and a staff of four. Now the head offices cover the whole of the site of Old Furnival's Inn, and the vast character of the business may be gathered from the fact that the total number of policies, ordinary and industrial, is over 19,000,000. The income of the Company for the year ended December last exceeded £16,500,000, and the capital funds are now more than £80,000,000, over £90,000,000 having been paid in claims. The management of the Industrial Branch of the business has of late been subjected to sharp criticism, but it will hardly be denied by the severest critics of its management that Sir Henry Harben, who for a long period was secretary of the Company, and afterwards and until his death its chairman, was a great administrator, who did a national service in popularising industrial and other insurance.

CORRESPONDENCE.

PRIORITY IN AEROPLANE THEORY.

Mr. O'Gorman condenses into a short note his views of the priority of Mr. Green in respect of certain results.

Now, questions of priority almost always lead to very prolonged and complicated discussions, and usually years pass, sometimes generations, before the supporters of the various claims cease to cap each other's references with references of still earlier date. With Mr. O'Gorman's permission, therefore, I shall not make myself responsible for either Monsieur Soreau's absolute priority or for the hard-and-fast date 1903. But though I do not definitely claim priority for Monsieur Soreau, I have no hesitation in denying it to Mr. Green. I presume Mr. O'Gorman's exposition at the meeting on December 1st to be the date of first publication of Mr. Green's results. That being so, I would refer him to Alexandre Sée's already classical memoirs collected in his book, "Les Lois Expérimentales de l'Aviation," published in Paris in the first quarter of 1911.

He will find that Figs. 87 to 99 deal very exhaustively with the graphical presentation of the familiar relations between weight, head resistance, inclination of supporting surfaces, velocity and engine power.*

* Eiffel ("La Résistance de l'Air et l'Aviation, Paris, 1910") gives an elegant variation of the graphical method in his polar diagrams, pp. 101–131.

He will note that these equations had been already presented by Soreau in his equally classical memoir, "État Actuel et Avenir de l'Aviation," read in January, 1908, to the Civil Engineers of France. No doubt he recollects that I presented the same equations at my lectures in the beginning of this year (February, 1911), and deduced the conditions for minimum power and minimum thrust, giving references to Soreau. (I might add that I obtained them independently in March, 1910, but mere independence of results rests on the word of the claimant, and the date of publication, or at least of communication to a recognised authority, is rightly held to be the criterion of priority.)

I would add that much of Sée's work is frankly adapted from Soreau. Mr. O'Gorman must also remember that results published in book form have usually appeared long before as scattered communications.

Writing away from a library, where reference is possible to the innumerable communications and memoirs scattered up and down the proceedings of the French Scientific and Technical Societies, I am unable to carry the discussion further. But let us remember that Pénaud established the classical condition for possible flight with given power, head resistance, reaction on planes, and weight (memoir published in 1872), in the 'seventies of last century.

He was followed by Renard, who completed his analysis, still in the nineteenth century.

Ferber began his gliding experiments in 1901, and carried the mathematical analysis still further. Finally, Soreau and Sée have completed the theory in the fullest detail. I mention only a few of the men whose work I am directly familiar with, leaving a host of names unmentioned.

This very sketchy note on the historical development of aeroplane theory has already taken up too much space. Others, no doubt, will fill up the many lacunae. But I cannot close without referring to the new ground taken up by Mr. O'Gorman in his letter. These equations, he states, have been applied to actual machines to predetermine their various characteristics. If he publishes his figures, he will make a real contribution to the practical development of British aviation, but will scarcely be able on that account to claim priority of method.

To conclude with some of my own experiments, let me state that I calculated similar characteristics for a Gnome-Bristol Biplane in October, 1910, that I determined 20° as the critical climbing angle, beyond which the machine "flops," and 16° as the utmost limit of correct flying on a calm day, and that I put these figures to a partial test by holding the machine at 12° inclination for a mile and a half, during which it climbed without any sensation of "flopping."

I often verified, by observation of pupils leaving the ground at too steep angles, that 16° to 20° was really in the neighbourhood of the point at which climbing gave way to "flopping." I have seen a pupil, unable to climb by pulling back the elevator, till his machine was inclined between 16° and 20° (a horrible sight), resolve to come down, push forward the elevator, and find himself soaring off like a bird at the smaller inclination.* The inclinations are referred to the horizontal axis of the machine.

Further, with a Vickers Rep Monoplane, tested at Brooklands in July 1911, we found from hard experience that there were two possible speeds (both theoretically stable, see Sée, Fig. 90). In practice, however, the lower speed had very poor stability laterally, and led to several bad landings soon after the get-off. Our pilots were accordingly instructed to get the machine's nose well down while running along the ground, and then to bring it up till the machine left the ground in the higher and more stable speed; otherwise there was risk of getting off the ground "cabré" in the lower speed with poor lateral stability. These two speeds are well known to Continental aeroplane flyers and designers equally with the poor lateral stability of the lower speed.

A. R. LOW.

DEW-PONDS.

One account I have read goes so far as to say that dew-ponds are so called because "they are believed to be fed by dew and vapours, *and not by rain*" (the italics are mine).

But surely no theory has ever been built upon so flimsy a foundation as this dew-pond theory:—*e.g.*, whenever Thomas Elliot, shepherd, "thought that a heavy dew or fog was to be expected, he notched a stick and drove it into the pond overnight, so that the notch was level with the surface. Next morning he pulled it up, marked how high the water had risen above the notch, and nicked it again for measurement." Mr. C. J. Cornish, who tells us this ("The Naturalist on the Thames," p. 129, 1902), calls the method a "simple and ingenious way." He does not tell us how the wetting of the stick by the fog or dew was allowed for, or what precautions were taken to ensure accurate reading. Under the circumstances the values given are modest. A gain of eight inches in depth of water on five winter nights is not too ambitious in point of quantity.

As for the idea, apparently much in favour with dew-pond theorists, that the "pans" in South Africa are dew-ponds constructed by aboriginal bushmen, one has only to see them to realise how absurd the suggestion is.

J. R. SUTTON.

Kimberley, South Africa.
November 17th, 1911.

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* Painlevé gives some very interesting notes on the characteristics of an aeroplane, but exaggerates the "acrobatism" necessary to maintain the lower speed. He deduces from purely theoretical considerations the paradox mentioned in this communication—that to climb, the pilot flying in the second speed must reverse the ordinary rules for control, *i.e.*, he must push forward the lever, depress the nose of the machine, decreasing his inclination and increasing his climbing powers. See *Technique Aéronautique*, January 1st, 1910.

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GENERAL NOTES.

Coach-building Prizes.—The Worshipful Company of Coach Makers and Coach-harness Makers of London offer the following prizes for competition among British subjects engaged in coach and coach-harness making and motor-body making, and members of drawing and technical classes in connection with such trades, resident in the United Kingdom of Great Britain and Ireland:—Competition No. 1 (open to all)—The Master, Mr. Frank Lindsay Sutton, offers £10 10*s*., and the Company £5 5*s*. and their silver and bronze medals, for a set of five working drawings of a Motor Caravan—side view—view of the interior (taken from back to front)—plan—front view—and rear view; all to the scale of 3 inches to the foot, and accompanied by detail drawings of the internal fittings so far as may be necessary to explain them. The caravan body divided into a small kitchen and a room in which four men can sleep, and which may be used as a sitting-room, with table, seats, etc. A tank to hold twenty gallons of water and a wash-hand stand and lockers for bedding, clothes, and some provisions, to be provided. The body suitable for a chassis with a wheel base 12 feet long, and 4 feet 4 inches wide from centre to centre of tyres. The body may overhang the chassis; in pencil, on paper 10 feet 6 inches by 5 feet 6 inches. Original improvements will receive special consideration. 1st prize, the Company's silver medal and £10 10*s*.; 2nd prize, the Company's bronze medal and £5 5*s*. Competition No. 2 (open to all)—For a set of four scale drawings—*i.e.*, off-side (showing levers, pedals and steering-wheel), sectional, half-rear and half-plan views—of a Limousine motor carriage-body with completely enclosed front and to seat six persons. No interior upholstery to be shown; the sectional drawing to be a perpendicular section taken lengthways through the middle of the body from front to back; designed for any known type of motor chassis of not more than 10 feet 6 inches wheel base; the wheels to be indicated by circles; details of chassis other than specified not required; scale, 1½ inches to the foot; in ink, on paper 48 inches by 36 inches. Original improvements will receive special consideration. 1st prize, the Company's bronze medal and £5 5*s*.; 2nd prize, £3 3*s*. Competition No. 3 (open to journeymen harness-makers)—For a black harness crupper for a 16-hand horse, brass furniture, buckle dock and small loops; to be the work of one man. It is suggested that harness-making firms assist by allowing competitors to effect the work where employed. 1st prize, the Company's bronze medal and £3 3*s*.; 2nd prize, £2 2*s*. Competition No. 4 (open to all)—For a sheet of drawings—on paper 48 inches by 36 inches—showing not more than six, and not less than three designs—to any scale—illustrating convenient methods for disposing of all the following accessories, viz.: Spare wheel with tyre complete, extra cover, two inner tubes, jack, pump, tools, accumulator, generator, fire extinguisher, tin of petrol, passengers' and driver's luggage (occupying a minimum space of 5 cubic feet), and luncheon basket, fitted to an open car for four persons, mounted on a chassis of 8 feet 6 inches body space; the spaces under the front and rear seats are not to be available. Only such parts of the body as are necessary need be drawn. Each drawing may be accompanied by a short explanatory description. Original improvements will receive special consideration. 1st prize, £5 5*s*.; 2nd prize, £3 3*s*.; 3rd prize, £1 1*s*. Competition No. 5 (open to youths under twenty-one years)—For a side view and half plan of a cab-shaped Victoria, without upholstery or leather work, suitable for one horse; scale, 1½ inches to the foot; in pencil, on paper 27 inches by 18 inches. 1st prize, £3 3*s*.; 2nd prize, £1 1*s*. Each of the prizes will be accompanied by the certificate of the Company.

Exhibition of Autocars and Aerial Navigation, Paris, 1912. — A commission has been appointed by the French Government for the purpose of organising an exhibition of Motor-cars and Aerial Navigation in Paris next year. The exhibition, which has the support of some of the most important firms in the trade, will probably be held in the Grand-Palais.

British Silk Exhibition, 1912.—Under the auspices of the Silk Association of Great Britain and Ireland, an exhibition will be held from June 5th–19th, 1912, at Prince's Skating Club, Knightsbridge, S.W., with the object of bringing before the public the great advance that has been made in the production of home-made silk fabrics. A special committee has been formed to deal exclusively with the financial and other arrangements for the exhibition, and an ample guarantee fund has been subscribed.

Oil Mills in Palestine.—Although the old-style olive mills are fast being replaced by the modern French machines, serig or sesame-seed oil is made in the district of Jerusalem by the old and primitive methods, except in one mill. The seeds are first soaked in water and then shelled by pounding in a large stone mortar with a huge wooden mallet. They are next roasted in an oven and then ground in a stone mill turned by a camel, the result being a thin greyish paste. This is then poured into a circular vat with a concave bottom. When the vat is full, the fluid being about three feet deep, a man gets into the vat and treads the paste with his bare feet, which brings the oil-cake to the bottom, and as the oil comes to the top it is skimmed off with a brass bowl. A German at Sarona has lately begun the manufacture of this oil with a European machine, the seeds not being roasted but simply crushed and pressed. The resulting oil is much lighter in colour and commands a better price, but it is stated that by this process less oil is obtained from the same amount of seed than by the native method.

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Scientific Fish Culture in Uruguay.—A work of considerable magnitude and interest is to be initiated by the new Uruguayan Minister of Industries, viz., fostering the fishing industry. He proposes to secure the services of a foreign expert in fish culture, and to establish a fisheries institute with a permanent fishing station on the east coast of Uruguay. According to the United States Consul at Montevideo, one of the professors of the agricultural college at Sayago, an authority on pisciculture, has been engaged for some time in a study of the sea and fresh-water fishes of the Republic. When his report is presented a bill will be prepared dealing with the question. The sea and rivers of Uruguay teem with edible fish, but as yet no attempt has been made to organise the fishing industry on a scientific basis, nor have any measures been adopted to protect the fish from extermination.

MEETINGS OF THE SOCIETY.

Cantor Lectures.

Monday evening, at 8 o'clock:—

Professor Vivian B. Lewes, "The Carbonisation of Coal." Four Lectures.

Syllabus.

Lecture IV. — December 18. — *The Possible Improvements in Carbonisation.*—The aims of the gas manager and coke producer—Experiments on low temperature distillation and their teaching—The rivalry existing between fully-charged retorts, vertical retorts, recovery ovens, and chamber carbonisation — The intermittent vertical retort *versus* the continuous vertical systems—The Settle-Padfield, Duckham-Woodall, and Glover-West processes—The ideals of carbonisation—The volume of gas due to primary and secondary reactions—The gasification of tar—The limitations of volume and quality of gas—The ends to keep in view in devising new processes of carbonisation.

MEETINGS FOR THE ENSUING WEEK.

Monday, December 18...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor Vivian B. Lewes, "The Carbonisation of Coal. Lecture IV.—The Possible Improvements in Carbonisation."

Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. F. Madan, "The Duplicity of Duplicates, with a Note on a New Bibliography."

British Academy, in the Theatre, Burlington-gardens, W., 5 p.m. (Schweich Lectures.) Professor R. A. Stewart Macalister, "The Philistines, their History and Civilisation." (Lecture II.)

Geographical, Burlington-gardens, W., 8.30 p.m. Dr. T. McDougal, "American Deserts."

British Architects, 9, Conduit-street, W., 8 p.m. The Practice Standing Committee on "The Newer Responsibilities of Architects."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Mr. W. Palin Elderton, "Some Recent Statistical Results."

East India Association, Caxton Hall, Westminster, S.W., 4.30 p.m. Mr. J. C. White, "A Short Description of Sikhim, Lhasa, and part of Tibet."

Tuesday, December 19...Statistical, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Mr. E. Crammond, "The Economic Position of Scotland and her Financial Relations with England and Ireland."

Illuminating Engineering Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. H. T. Harrison, "Some Aspects of Railway Station and Goods Yard Illumination."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on paper by Dr. T. E. Stanton and Mr. J. R. Pannell, "Experiments on the Strength and Fatigue Properties of Welded Joints in Iron and Steel."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Sir George Scott, "Burma the Cinderella."

Wednesday, December 20...Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Mr. W. Larden, "Solar Halos and Brocken Spectres." 2. Mr. W. H. Dines, "The Statical Changes of Pressure and Temperature in a Column of Air that accompany Changes of Pressure at the Bottom."

Geological, Burlington House, W., 8 p.m.

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. F. Shillington Scales, "Photomicrography of the Electrical Reactions of the Heart." 2. Rev. H. Friend, "British Tubificidæ."

Thursday, December 21...Linnean, Burlington House, W., 8 p.m. 1. Rev. H. Friend, "Some Annelids of the Thames Valley." 2. Mr. R. C. Compton, "The Seedling Structure of Leguminosæ." 3. Professor P. Groom, "The Internodes of *Calamites*." 4. Mr. W. C. Worsdell, "Some Abnormal Toadstools and their Morphology." 5. Dr. A. B. Rendle, "Dissected Leaf-form of Horse-radish."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. R. H. Pickard and J. Kenyon, "Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part II.—The Rotations of Some Secondary Alcohols containing the Iso-propyl Group." 2. Messrs. R. H. Pickard and W. O. Littlebury, "The Alcohols of the Hydroaromatic and Terpene Series. Part II.—The Menthols corresponding to Optically Inactive Menthone." 3. Messrs. J. J. Dobbie and J. J. Fox, "The Absorption Spectra of Quinine, Cupreine, 6-methoxy-quinoline and 6-hydroxy-quinoline."

Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m. 1. Mr. C. Olden, "Emeralds: Their Mode of Occurrence and Methods of Mining and Extraction in Colombia." 2. Mr. W. C. Walworth Pearce, "The 'Glen' Bismuth Mines, North Queensland." 3. Mr. F. A. Killik, "Notes on a Simple Method of Separating Rock from Stiff Clays." 4. Mr. H. R. Sleeman. "The Whim Well Copper Mine, West Pilbara, North-west Australia."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. H. W. Fincham, "A Ramble in Old Clerkenwell."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Professor A. Szelagowski and Mr. N. S. B. Gras, "The Eastland Company in Prussia."

Numismatic, 22, Albemarle-street, W., 6.30 p.m. Sir Arthur J. Evans, "The Artistic Engraver of the Terina Mint and the Signature of Evaenetos on his late Didrachm Dies."

Correction.—In a note on page 80 of the last number of the *Journal*, it is stated that the date of William Kay's birth is given in Lord's Memoir as 1765. This is a mistake. The William Kay born in 1765 was the grandson, not the son, of John Kay. The date of the birth of William Kay the elder is given, no doubt correctly, by Lord as July 14th, 1745.

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Journal of the Royal Society of Arts.

No. 3,083. VOL. LX.

FRIDAY, DECEMBER 22, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

CANTOR LECTURES.

On Monday evening, December 18th, Professor VIVIAN B. LEWES delivered the fourth and final lecture of his course on "The Carbonisation of Coal."

On the motion of the CHAIRMAN a vote of thanks was accorded to Professor LEWES for his interesting course.

JUVENILE LECTURES.

The usual short course of lectures adapted for a juvenile audience will be delivered on Wednesday afternoons, January 3rd and 10th, at 5 o'clock, by CHARLES VERNON BOYS, F.R.S., on "Soap Bubbles."

Each Member is entitled to a ticket admitting two children and an adult.

A sufficient number of tickets to fill the room will be issued to Members in the order in which applications are received.

Members who require tickets for the course are requested to apply for them at once.

Syllabus.

LECTURE I.—JANUARY 3.—The surface actions of water and other liquids—Peculiar properties of solutions of soap and of saponine with which bubbles may be blown—The strength of bubbles—Soap films on frames—Froth—Composite bubbles.

LECTURE II.—JANUARY 10.—Out-of-door bubbles—Floating bubbles—Soap bubbles as an aid to experiment—Experiments with soap bubbles—The colours of soap bubbles—Permanent celluloid films showing the colours of soap bubbles.

The lectures will be illustrated by numerous experiments.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE CARBONISATION OF COAL.

By VIVIAN B. LEWES,

Professor of Chemistry, Royal Naval College, Greenwich.

Lecture I.—Delivered November 27th, 1911.

THE COMPOSITION OF COAL.

The carbonisation or destructive distillation of coal is carried out with the object of obtaining the latent energy which it contains in such a form that when liberated it can be most easily applied to our special needs, and as coal consists of a complex mixture of carbon with compounds of carbon, hydrogen, and oxygen, which can be broken up by the action of heat into solid, gaseous, and liquid products, processes of destructive distillation have arisen in which, by varying the temperature and methods of carbonisation, it has been possible to obtain the best results either in the gaseous or solid products, according to whether the operation has been carried out at the gasworks with the object of making illuminating gas, or in the coke oven in order to make metallurgical coke.

Before it is possible to explain the highly complex actions taking place in the destructive distillation of coal, it is important to have some definite idea of the nature of the raw material with which we have to deal, and although many attempts have been made to gain an insight into the composition of coal, the wide variations in its characteristics, the difficulties attending any attempt to separate its constituents, and the

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ease with which the products of its decomposition undergo secondary changes at the temperatures employed in breaking it up have prevented any very satisfactory solution of the problem being arrived at.

The one thing generally admitted is that coal is the fossil remains of a vegetation that flourished in the carboniferous period of the world's history, and that it has passed through successive stages of checked decay, the action of time, temperature, and pressure, generally out of contact with air, resulting in the conversion of these remains into the tertiary coals, such as brown coals or lignites, and probably by a continuance of the action yielding eventually the true coal.

In a previous course of Cantor Lectures I went into that wonderful cycle which, in Nature, purifies the atmosphere by utilising the waste products of life and decay—water vapour and carbon dioxide—as the food on which the vegetable kingdom is reared, and showed that, under the influence of the sun's rays, the growing plant built up its tissue from the carbon, hydrogen, and oxygen of these bodies, at the same time rendering latent and storing the solar energy in the compounds formed, and that these, converted by time, temperature, and pressure into coal, after countless ages yield back on combustion the heat that was derived from the prehistoric sun.

So far all authorities are agreed, but the changes which take place in the conversion of the plant material into the coal, and the nature of the compounds present in the various kinds of coal, which give this body its widely diverging characteristics, still remain unsolved in spite of the century of work which has been expended on the question, and the fact that it has been attacked from almost every point of view.

The chemical theories that have been brought forward nearly all start with the assumption that the original material from which the coal has been formed is $n(C_6H_{10}O_5)$, an empirical formula which represents the class of bodies known as "celluloses," and in which the ratios of the atoms lend themselves to an easy explanation of the formation of various kinds of coal by the subtraction of various proportions of the known gaseous products of the checked decay taking place in the formation of peat, lignite, and coal—*i.e.*, methane, CH_4, carbon dioxide, CO_2, and also water, H_2O.

Some theorists have held that the infiltration of water holding oxygen in solution was responsible for actions which, leading to the evolution of these compounds, have resulted in the concentration of the carbon; others have looked upon the action as one of dehydration, and both are probably right to the extent that the conditions under which coal has been formed are so various that cases could be found to support either theory.

Moreover, such theories are rendered invalid by the fundamental errors of supposing that Nature is dealing with purified cellulose, and that the various coals are definite compounds that can be represented empirically by a formula.

Our only knowledge of the coal plants is derived from their fossilised remains, and owing to the complete nature of the destruction that has taken place in structure, the evidence to be obtained is small indeed; but although of a totally different and far more simple form, it must be that the plant life of the carboniferous period which gave rise to our coal deposits varied as much in character as does the sphagnum of a peat bog from the timber of a forest.

Although the vegetable fibres of all forms produced by plant life contain cellulose, they also contain ligno-cellulose and other allied compounds, whilst they vary in the extractive matter of their sap to a very great extent, so that even supposing they all underwent the same treatment as regards time, temperature, and pressure during their conversion into coal, we should expect wide differences in composition in the coal formed, whilst as the conditions vary even more than the material dealt with, it is small wonder that great differences are found between the coals from every seam in a colliery, and even between different parts of the same seam.

Impossible as it is to give accurate explanations of changes such as those taking place under conditions of which we know only the general trend, and in material the composition of which is of the most variable character, we are met by the further difficulty that when we have the coal itself, its refractory behaviour towards solvents and any ordinary reagents prevents our learning much more about its constitution than can be given by an ultimate analysis giving its percentage composition, or a proximate analysis showing the effect upon it of heat in causing it to yield fixed carbon, volatile matter, ash, and moisture.

It is quite clear that in our present state of knowledge all that is possible is a generalisation based upon the known facts, the truth or otherwise of the theory being shown by how far it is in accord with the observations made in

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practice upon the results yielded by destructive distillation.

Twenty years ago I came to the conclusion that the most satisfactory view to take of the composition of coal was that it consisted of an agglomerate of the solid degradation products of vegetable decay, together with such of the original bodies as had resisted to a greater extent the actions to which it had been subjected, and all the experience of wood, peat, and coal carbonisation which I have had since confirms me in the opinion that this is in the main correct.

All the plants of which we have fossilised record in our coal measures consisted of sedges and reeds, tree ferns, club mosses or lycopodia, and trees akin to the pine; but in those prehistoric days the conditions of growth—warmth, moisture, and carbon dioxide—were such that these plants grew with a succulent freedom and rapidity unknown in latter days, and this rendered their tissue an easy prey to decay and fermentation, actions which left only the more resistant unchanged. The work of Morris, Carruthers, Fleming, and Huxley has shown us that the bituminous matter in coal is largely derived from the spores of fossil mosses akin to the lycopodia.

If we take the club mosses of to-day, we find that their spores give us that body known as lycopodium, a substance so resinous in its nature that it resists the action of water, and is used to coat pills, whilst the same resinous characteristics render it so inflammable that a little blown through a flame provides the theatrical world with its artificial lightning. Spores of this character from the giant growths of the carboniferous period, together with the more resinous portion of plants akin to the pine, are the substances which have resisted the actions taking place during the ages that have elapsed in the formation of coal.

Our knowledge of the constituents entering into the multitude of changes taking place in the formation of coal is restricted to carbon, hydrogen, and oxygen; but it is improbable that the mineral constituents of the sap and fibre of the original vegetation play any important part in the actions that lead to the change, as although the reduction of sulphates to sulphides, and the combination of the sulphur with iron from the surrounding soil to form pyrites and organic compounds containing sulphur, and the deposition in the mass of other water-carried salts, all tend to the production of the ash of the coal, they do not affect the carbonaceous material in its main changes.

In the same way nitrogen compounds, which are found in every fuel of vegetable origin, are present in all stages of the formation from peat to coal, but it is impossible to suppose that they play any part in the change, whilst water, although it is probably an active factor and also a product in the decompositions, cannot be taken into account in considering the actual course of the changes from analyses of the body produced. Hence, in tracing the probable course of the degradation of the vegetable matter through its various stages, it is better to ignore all such factors and deal only with the variations of the carbon, hydrogen, and oxygen in the material.

Starting with the fibre of the original plants, we find two well-defined bodies—cellulose, as represented by cotton fibre, and lignose, as represented by jute fibre; in the former the percentage of carbon is 44, in the latter 47, each giving distinctive reactions with dilute acids at 70° C., with anilin sulphate, with Schultze solution, and with mixtures of sulphuric and nitric acids. In the cellular tissue we find starch, and besides these bodies there are present the extractive and mineral matters of the sap.

Amongst the extractive matter we find gums, such as those exuding from the acacia and cherry, but also present in the juice of many plants, mucilage, vegetable jelly, which gives many juices their power of gelatinising, resins, essential oils, and other well-defined bodies. With some forms of vegetation the essential oils undergo oxidation and form resins, and these, being more resistant to change, accumulate in masses of decaying vegetable matter, so that large quantities of them are found in lignite beds in a fossilised but little changed state.

The changes in the carbohydrates and extractive matters depend largely upon the conditions of decay. Given moisture and air, they become converted into carbon dioxide and water; check the decay by cutting off free access of air, the action is slowed down, and the gases evolved are carbon dioxide and methane.

It is clear that in a mass of rotting vegetation undergoing checked decay, fermentation must play an important part, and Renault* found, in an extensive series of researches upon peat, that the most important factor in the conversion of vegetable deposits into peat were fungi and

* *Bulletin de la Société de l'Industrie Minérale*, 3 Sér., XIII. 865.

bacterial ferments, which give rise to the production of ulmic compounds of the composition:—

Carbon	65·31
Hydrogen	3·85
Oxygen	30·84

Mulder* also at an earlier period found that bodies could be extracted from peat, to which he gave the name of humic and ulmic acids, and Einof, Proust, and Braconnot found that such bodies form the chief portion of peat:—

	Carbon.	Hydrogen.	Oxygen.	Nitrogen.
Humic acid	60·13	4·74	31·52	3·61
Ulmic acid	62·03	4·65	33·33	—

Whilst Herz† found bodies of the same character in lignites, which he called carbo-humic and carbo-ulmic acids, of the composition:—

	Carbon.	Hydrogen.	Oxygen.
Carbo-humic acid	64·59	5·15	30·26
Carbo-ulmic acid	62·36	4·77	32·87

Fremy‡ also found that not only lignites, but bituminous coals could be dissolved in a mixture of mono-hydrated sulphuric acid and nitric acid, giving a dark brown solution, from which an ulmic compound is entirely precipitated by water; whilst Anderson§ has shown that by similar treatment bodies of the same character can be obtained from both caking and non-caking coals.

None of these bodies are probably definite compounds, and resemble the residues obtained by the action of dilute acids on sugar and starch.

The evidence, however, seems to point to the presence in all bituminous forms of coal as degradation products of the original vegetation of a humus or ulmic character, which is probably the portion carrying the nitrogen, and in round numbers the proportions of the carbon, hydrogen, and oxygen will be not far removed from:—

Carbon	63 per cent.
Hydrogen	5 ,,
Oxygen	32 ,,

It is also well known that the tertiary coals, like the brown coal and lignite deposits, are rich in fossil gums and resins, derived from the extractive matter of the vegetation, and a number of these have been isolated and analysed, whilst Mulder has found resinous bodies of a similar character in the Friesland peat. (See table below.)

It will be noticed that the products from the lignite differ but little from Mulder's peat resins, whilst it is interesting to note that in the lignite beds of Saxony layers of opaque yellowish brown matter are found (the pyropissite of Kenngott), which yields up to 62 per cent. of paraffin on distillation, and is the body from which Wackenroder and Bruckner extracted their resins.

It is evident that in coal there are resin bodies of this character approximating to the general composition:—

Carbon	79 per cent.
Hydrogen	11 ,,
Oxygen	10 ,,

The amount of resin constituents in the original vegetation, which concentrates itself in the coal, must play an important part in chemical changes taking place during the formation and ultimate composition of the coal; and it is clear that although the vegetation that flourished in the coal age was of a very different character from that of later periods, yet in all probability the variations in the extractive

* *Jour. für Chem.*, 21, 321.
† N. Report, 10, 496.
‡ "Die Physiographie der Braunkohle," p. 5.
§ *Jour. Soc. Chem. Ind.*, XVII., 1018.

	Source.	Observer.	Analysis. Carbon.	Hydrogen.	Oxygen.	Name.
Peat (dark)	Friesland	Mulder	76·31	10·98	12·71	Beta-resin.
,, ,,	,,	,,	78·05	11·94	10·01	Gamma-resin.
,, ,,	,,	,,	79·70	12·15	8·15	Delta-resin.
,, (light)	,,	,,	75·12	10·21	14·67	Alpha-resin.
,, ,,	,,	,,	79·43	12·54	8·03	Gamma-resin.
Lignite	Saxony	Wackenroder	78·20	12·30	9·50	Cerinin.
,,	,,	,,	81·97	11·47	6·56	Leucopetrin.
,,	,,	Bruckner	77·35	10·20	12·45	Georetic acid.
,,	,,	,,	80·27	13·37	6·36	Geomyricin.
,,	,,	,,	78·64	12·70	8·66	Geoceric acid.
,,	New Zealand	Hauer	76·53	10·48	12·80	Ambrite.
,,	Bohemia	Laurentz	81·47	8·71	9·82	Anthracoxene.
,,	Moravia	Schrotter	80·40	10·68	8·74	Retinite.
		Mean	78·65	11·36	9·88	

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matters of the plants varied to much the same extent as in the flora of to-day, so that some deposits would be formed from vegetation containing but little of the resin-forming constituents, whilst other deposits would be rich in them. We know the wide differences there are in the physical characteristics of the lignites, sometimes more like wood than coal, at others black, shining, and with a conchoidal fracture, these variations in appearance being due to the conditions under which they have been formed and the amount of the resin constituents present.

If we start with the humus and resin constituents as they exist in the peat deposits of to-day, the latter are present only to the extent of 5 to 10 per cent., but in the decaying vegetation of the carboniferous age were probably present in much larger quantities, and the humus, unprotected by it, rapidly undergoes decomposition with concentration of carbon and evolution of methane, carbon dioxide, and water. As the layers of deposit above the carbonising mass grow thicker, so probably the temperature rises, and the ratio of resin constituents increasing in proportion binds together the mass, and so helps to protect the remaining humus, and with the lapse of centuries lignite is formed.

If the amount of resin constituents has been small or, owing to local circumstances, has not been distributed evenly throughout the mass, the lignite is loose in structure, and during the ensuing ages continues decomposing until, if the pressure has been great and the temperature high, nothing but the residual basis and trace of resin constituent are left in the form of steam-coal or anthracite, whilst under other conditions they may remain mixed with the bituminous coal in a seam and form the "Mother of Coal."

If the percentage of resin bodies has been very high, as in a drifted deposit of spores from lycopodia, and the temperature has been high, the resin bodies may become semi-liquid, and mingling with surrounding earthy deposits, will give such compounds as the Boghead cannel, the organic matter in which has the same composition as resin, whilst it yields 33 per cent. of ash. Some of the cannels, however, are simply very rich bituminous coals.

When the temperature has been high enough some of the resin constituents have practically distilled into the underlying clay, yielding some forms of shale.

Heat also may cause isomeric and other changes in the resin bodies, thus altering their behaviour towards solvents, whilst the effect of heat under pressure upon the resins is in some cases to decompose them with formation of hydrocarbons, a long series of which were isolated by Renard, amongst them being both saturated and unsaturated groups, together with hydrocarbons containing oxygen. Hydrocarbons like retene, $C_{18}H_{18}$, have frequently been isolated, and this body is found in many lignites, whilst within the last few months Pictet and Ramseyer have isolated hexahydrofluorene, $C_{13}H_{16}$, and others of the hydroaromatic hydrocarbons from coal, bodies which are resolved into aromatic hydrocarbons and hydrogen during destructive distillation. Renard long ago isolated not only saturated hydrocarbons like pentane and hexane, but also hexahydrides or naphthenes, isomeric with the ethylene series, from the resin-oil obtained by distilling wood resin at a low temperature (350° C.), amongst these hexahydrides being C_7H_{14}, C_9H_{18}, and $C_{10}H_{20}$, and the presence of bodies of this character in low temperature coal tar is a further proof of the presence of the resin bodies in coal.

All these degradation products of the original vegetation are to be found in the bituminous coals, the residual body and humus forming the basis, which is luted together by the hydrocarbons and resins, and the characteristics of the various kinds of coal are dependent upon the proportions in which the four groups of the conglomerate are present.

These constituents of the coal have their own characteristic products of decomposition when the coal is subjected to carbonisation.

The humus bodies during carbonisation yield a large proportion of the gaseous products, and under the influence of heat show no sign of melting, but begin to break up at about 300° C., the decomposition becoming more rapid as the temperature rises. Water distils over in the early stages, the tar is thin and poor in quantity, and the gases up to 600° C. consist of hydrogen, methane, and carbon dioxide, with smaller quantities of carbon monoxide and traces of other saturated hydrocarbons; the decomposition can be completed below 600° C., but if the temperature is run up to 1000° C., the carbon dioxide is reduced in quantity by the action on it of the red-hot carbon, and carbon monoxide increases correspondingly, whilst hydrogen and methane are still evolved.

The decomposition of the humus is also largely affected by the rate of heating; if slowly heated, a large proportion of the oxygen is given off in combination with hydrogen as water vapour, whilst, if quickly raised in temperature, more

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combines with carbon to form carbon dioxide and monoxide.

The residue shows no sign of caking, whilst, like the naturally-formed residue—mother of coal—it requires a large proportion of cementing material to make the particles cohere.

The resin bodies and hydrocarbons which form the cementing portion in the coal melt between 300° C. and 320° C., and if a coarsely-powdered sample of the coal becomes pasty or semi-fluid at this temperature, it is a strong inference that the coal will coke on carbonisation, a fact noted by Anderson, and which I have found very useful in practice as a rough test. About these temperatures also the resin bodies and hydrocarbons begin to decompose.

The resin bodies at low temperature yield saturated hydrocarbons, unsaturated, chiefly hexahydrides or naphthenes, together with some oxygenated compounds, whilst the hydrocarbons yield paraffins and liquid products, all these primary constituents undergoing further decomposition at slightly higher temperatures. The liquids so produced begin to distil out as tar vapours and hydrocarbon gases, and leave behind with the residuum pitch, which at 500° C. forms a mass already well coked together if the residuum from the humus is not too large in quantity. The coke formed at this temperature is, however, soft, but if the heat be now raised to 1000° C., the pitch residue undergoes further decomposition, yielding gas and leaving carbon, which binds the mass into a hard coke.

It has been shown by Muck and other observers that it is not always the coal containing the largest amount of volatile matter that evolves gas most rapidly or is richest in hydrocarbons, and this naturally follows from the fact that those coals which have the highest oxygen percentage are mostly those giving high volatile matter, and as these are rich in the humus bodies which yield most of the diluting gas and but little tar or rich hydrocarbon gases, they cannot give the high result of a coal in which the oxygen content is about 10 per cent. or rather lower, and which contains a large percentage of resin bodies.

Observers have differed as to the nature of the binding material in coke, some holding that it is the residuum of the semi-fused constituents of coal, whilst others, chief amongst whom was Wedding, consider that it is carbon shed off by the decomposition of heavy hydrocarbon vapours, which is undoubtedly the cause of the carbon hairs found in coking. My own opinion is that the cementing material is due to liquid products, the most volatile of which go off as vapours leaving pitch, which carbonises and binds the mass into coke, and in considering the actions taking place during carbonisation ample proof of this will be adduced.

It is clear that the binding material is formed below 450° C., as if we take a good coking coal and carbonise it at 450° C., we obtain coke which, although not strong, is perfectly luted together; but if we now powder this low temperature coke and again carbonise it, a large yield of poor gas is evolved, but no coking of the residue takes place.

There is no doubt in my mind that it is the resin bodies and their derivatives the hydrocarbons in the coal that form the tar, which yields the pitch which lutes the coke, and also that the resin bodies play a very important if not the chief part in the weathering of coal.

Experience shows that the weathering of coal is a phenomenon which is dependent upon the absorption of oxygen from the air, and this weathering is fatal to the coking of some coals, the slacks of which are so susceptible to oxidation that a few days' or weeks' exposure destroys their coking power.

Now, the avidity of oxygen for some vegetable resins is well known—the rapidity with which copal will absorb oxygen from the air may be taken as an example, and common resin has itself been formed by the oxidation of turpentine, and countless ages under conditions tending to reduction may well have whetted anew the resinic appetite for oxygen.

In any case, the resin bodies are the compounds present in the coal most likely to possess this property, and it is the chemical actions so caused which lead to slow combustion, and, when accelerated by any rising in the surrounding temperature, are capable of generating sufficient heat to lead to the spontaneous ignition of masses of broken coal large enough to prevent the escape of the heat as it is developed.

Coal exhibits to a lesser extent the same property of absorbing gases that charcoal does, and the least absorbent will take up one and a quarter times its own volume of oxygen, whilst many bituminous coals will absorb more than three times their volume of the gas; and this action, at first largely physical, presents the oxygen in a probably active condition to the resin bodies in the coal, and leads to the rapid "weathering" and destruction of the coking properties found with some kinds of coal.

Boudouard * has shown that when coal is

* *Compt. Rend.*, 1909, 148, 284-286.

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weathered, humus bodies are produced, and the coking power lessened or destroyed. In seven samples of various coals the humus constituents were increased by the oxidation, which seems to show that the action of the absorbed oxygen is to attack the resin compounds, and as we know that carbon dioxide and moisture are the chief products of the earlier stages of heating of masses of coal, it seems probable that the result is a conversion of resinic into humus bodies with evolution of these gases, and it is this change which leads to the serious deterioration in the gas and tar made from coal which has been too long in store, whilst the fact that cannel coals like Boghead or a shale do not weather is partly due to their dense structure, and also is an indication that the resin bodies of which they are chiefly composed are of a different type—a fact borne out by their resistance to certain coal solvents which freely attack the ordinary resin matter.

The lines of research intended to throw light on the composition of coal have been either to distil the coal at various temperatures and to draw inferences from the products of the nature of the original substance, or to attack the coal directly by means of solvents.

The early attempts to isolate definite bodies from coal by solvents were none of them very successful, ether, alcohol, petroleum ether and benzol proving to have but little solvent action, whilst Guignet succeeded in extracting by the use of phenol a small quantity of a brown amorphous body from a bituminous coal, but did not identify it. In 1894 Professor Bedson reported to the British Association the results of a long series of experiments, in which, besides these solvents, he also tried acetic anhydride, glacial acetic acid, turpentine and anilin, the last solvent proving the most successful, extracting from the coal a body of the same character as that obtained by Guignet, which, when treated with benzene and with ether yielded on evaporation bodies of a resinous character. He also found that when finely-divided coal is suspended in boiling water and permanganate added, oxidation of some constituents of the coal ensues, and a dark brown alkaline liquid is formed.

In a further report in 1896 he gave the results of acting upon coal with hydrochloric acid and potassium chlorate, and showed that chlorinated compounds are formed of the same character as those obtained by Cross and Bevan from jute fibre.

Bedson made a great advance in this line of research when in 1899* he pointed out the solvent power of pyridine bases extracted from coal tar, which dissolved 16 to 18 per cent. of a Durham coal, but had no action on anthracite.

In 1901 Baker † experimented upon the action of this solvent on several coals, and found that from Durham coal (Hutton seam) 20·4 per cent. could be extracted from pyridine, and that after extraction the residue had lost the coking properties of the original coal.

This observation was confirmed, in 1902, by Anderson and Henderson ‡ who tried the action of pyridine in a research upon the coals of Bengal and Japan, and also upon some Scotch coals, the coking powers of which were known, and they found that the extraction of a strongly coking coal by pyridine weakened the coke, whilst with inferior coking coal the property is entirely destroyed.

In 1908 Professor Bedson § read a paper before the Society of Chemical Industry, in which he gave the results of experiments upon six coals obtained from the Redhaugh Gasworks, which seem to show that with some gas coals an amount equal to practically the whole of the volatile matter capable of being driven off by heat can be extracted by pyridine:—

	Volatile matter per cent.	Pyridine extract per cent.	Gasworks yield per ton.	Candle-power.
I. . . .	34·10	32·36	11,381	16·63
II. . . .	33·28	35·59	11,392	16·50
III. . . .	31·91	24·58	11,646	16·40
IV. . . .	31·7	22·81	11,108	16·00
V. . . .	33·65	29·97	10,913	16·39
VI. . . .	30·87	22·53	10,730	15·76

Now, from these figures the inference is that in a coal like II. everything beside the fixed carbon and ash has been dissolved—that is, the humus, resin, and hydrocarbon bodies, and it would have been of the greatest interest had Professor Bedson made an analysis of the residue, or at any rate shown that no volatile matter was left in it.

I have never had the good fortune to obtain a coal from which the pyridine extracted a percentage equal to the volatile matter as given by analysis, even after much longer periods than those utilised by Professor Bedson, but such a coal offers a most valuable field for further examination.

The humus bodies in coal are by far the most resistant portion of the volatile matter to the solvent action of the pyridine, and are practically insoluble, but there are also undoubtedly some

* *Trans. North Eng. Min. Engineers*, 1899, 82-87.
† *Ibid.*, 1901, 23-28.
‡ *Jour. Soc. Chem. Ind.*, 1902, 223, 237.
§ *Ibid.*, 1908, 147.

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forms of resin constituents in coal which are nearly insoluble.

Bedson found that the volatile matter in cannel coal varied very much in its solubility, whilst the hydrocarbons in shale were insoluble, and yet the destructive distillation of these bodies shows them to be very rich in resin constituents.

It appears probable that in a feebly coking coal the coking property is due almost entirely to the soluble form of resin constituents, and can, therefore, be entirely removed by extracting the coal with pyridine; whilst, on the other hand, in strongly coking coals the property is due partly to soluble resin bodies, but to an even greater extent to other hydrocarbons of resinic origin, which resist the solvent action of the pyridine, so that the coking property is weakened but not destroyed by extraction.

A similar conclusion was arrived at by Anderson and Roberts * in 1898 from an entirely different point of view. Dr. Percy, more than fifty years ago, pointed out the fatal effects of weathering upon certain coals and slacks, and showed that if a fairly good coking coal was kept at a temperature of 300° C. for a few hours, and is afterwards heated to redness, it does not swell and coke; and Anderson and Roberts, in trying this with various Scotch coals, found that, although it was true for a coking coal of medium power, a really strongly coking coal had the power only weakened, and they found also that the same phenomenon could be brought about by treating the two coals with sodium hydrate; and the conclusion is that although resinous bodies which can be saponified or oxidised contribute largely to the coking, yet there are also present non-saponifiable bodies, which, in breaking up under the influence of heat, yield enough luting to form coke; and I think the action of pyridine shows that this non-saponifiable body or bodies consists of substances very probably akin to those found in shale and some cannels.

Burgess and Wheeler,† in a paper read before the Chemical Society this year, took a Silkstone coal containing 33·4 per cent, of volatile matter, and succeeded in extracting 30 per cent. by means of pyridine, leaving a coke-like residue, which on distillation at 900° C. yielded hydrogen and oxides of carbon—they would have found methane as well if they had looked for it—whilst the extract on destructive distillation yielded a mixture of the paraffin hydrocarbons and hydrogen.

* *Jour. Soc. Chem. Ind.*, 1898, 1013.
† *Chem. Soc. Jour.*, 1911, 654.

At first sight this looks as if pyridine was a solvent which could be used to separate the humus and resin constituents, but Messrs. Burgess and Wheeler are careful to point out that "they hesitate to identify absolutely the paraffin-yielding constituents of coal with that portion extracted by pyridine," and they are wise in being cautious, as there are several anomalies to be cleared up. I have found several times that after extraction the residue contains as much and sometimes more volatile matter than the original coal, in spite of repeated washings with acid, drying in vacuo, and other forms of treatment intended to eliminate all pyridine; whilst the composition of the extract also shows anomalous results, and after the most careful measures have been taken to free it from pyridine, it will sometimes still contain more nitrogen than did the original coal.

It is to be noted that so far the two most successful coal solvents have been anilin and pyridine, both of them alkaline organic bases, and as we have seen that the effect of extraction by pyridine has been the same upon the coking power of the coal as treatment with sodium hydrate, which saponifies the resin constituents, it seems highly probable that the pyridine forms a compound with the resin bodies or some portion of them, and this compound is soluble in excess of pyridine, and if this is so, it should be traceable by the presence of nitrogen in the extract.

In an experiment made by Baker* he treated coal from the Hutton seam with pyridine, and after carefully freeing the residue and extract from pyridine, analysed them with the following results:—

20·4 per cent. extracted.

	Original Coal.	Residue.	Extract.
Carbon . . .	80·82	82·06	79·37
Hydrogen . .	4·66	4·85	5·79
Oxygen . . .	10·81	9·65	10·73
Nitrogen . . .	1·84	1·78	2·66 ?
Sulphur . . .	1·84	1·23	1·40

and he queries the nitrogen in the extract, evidently thinking it a mistake.

Anderson† also analysed a Bannockburn main coal and the matter extracted from it by pyridine:—

12·8 per cent. extracted.

	Original Coal.	Extract.
Carbon	86·70	83·39
Hydrogen	5·38	6·05
Oxygen	5·94	7·30
Nitrogen	1·98	2·86

* *Trans. North Eng. Min. Engineers*, 1901, 23–26.
† *Jour. Soc. Chem. Ind.*, 1898, 1013.

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In each case there was a large increase in the nitrogen, and Baker's analysis of the residue shows that it did not come from the coal, and the probabilities are that the extract is a feeble compound of the resin body and pyridine. In the case of the Hutton coal, the coking power was destroyed by extraction, and in the case of the Bannockburn coal weakened.

The extracts when distilled gave very large volumes of rich gas, and left a strong but intumescent coke.

The residues after extraction show a still more remarkable anomaly. As it is manifestly the resin constituent which has been extracted, one would expect that on determining the volatile matter in the residue it would be found to be as much lower as the amount extracted, but it proves to be very nearly as high, and in many cases higher than in the original coal.

Anderson and Henderson, in their examination of coals by pyridine, give the loss of weight of the residues from the extraction on heating. which are here contrasted with the original volatile matter in the coal:—

Volatile.	I.	II.	III.	IV.	V.
In original coal .	31·98	39·89	46·59	27·4	36·78
In residue . . .	39·26	44·14	49·14	29·6	43·02
Per cent. extracted	10·8	7·0	21·7	12·8	14·5

This increase in the amount of volatile matter present in coal can mean only that the pyridine has attached itself to some constituent in the coal to form a compound insoluble in excess of pyridine, but the only analysis published of a residue with the percentage of nitrogen determined (Baker) shows no sign of this, as the nitrogen is the same as in the original coal, but the volatile matter in the residue is not given.

In an experiment upon a Durham coal (Londonderry) made in my laboratory, the following results were obtained:—

The coal lost 18 per cent. of its weight to the pyridine.

	Original ash and moisture free.	Residue from pyridine.	Pyridine extract 18 per cent.
Carbon . .	82·87	79·15	81·04
Hydrogen .	5·57	4·71	7·18
Oxygen . .	8·72	14·00+	7·98+
Nitrogen . .	1·68	2·14	3·80
Sulphur . .	1·16	not determined	not determined
Fixed carbon	63·00	64·46	,,
Volatile . .	37·00	35·54	,,

\+ oxygen plus sulphur.

In this determination, the increase in nitrogen over the amount present in the original coal in both residue and extract points to the presence of compounds of pyridine in both, whilst the increase in hydrogen in the extract, taken in conjunction with the decrease of hydrogen in the residue, points to its having been a resin body that was dissolved.

These considerations seem to make it clear that the resin constituents condition the coking of coal during destructive distillation, and that they are of at least two kinds—the one easily oxidisable, soluble in pyridine and saponifiable by alkalies, which on weathering is oxidised into a humus body with evolution of water and carbon dioxide, and is responsible for the heating of coal; the other class non-oxidisable, not saponified by alkalies, and forming with pyridine a compound insoluble in excess of the reagent, and this class may be the hydrocarbons from decomposed resins, as the residue in which they are present yields rich liquid hydrocarbons, as tar and pitch, but not rich gas.

My own opinion is that although pyridine is a better solvent for coal than any other of which we know, yet that it will never prove more than a useful first step in the separation and identification of the complex mixtures present in the coal, whilst even then pyridine has an awkward knack of attaching itself to other molecules, which makes it difficult to get rid of without using such drastic measures as are quite likely to alter the nature of the bodies dissolved in it.

Several observers are at work upon the problem, and it is to be hoped that satisfactory results will soon throw light upon this complicated subject.

Coal always contains a certain proportion of water, which appears to be held partly mechanically and partly in some form of combination, and in this it resembles wood, which after long air-drying still retains an average of 20 per cent. of moisture, which, if got rid of at an elevated temperature, is reabsorbed from the air. The mechanically held portion in coal is generally known as "pit-water," and represents ordinary wetting, which can be got rid of by air-drying; but the so-called "hygroscopic water" is driven out only by drying at 105° C., and as this heating for some hours causes oxidation of the resin bodies, it also tends to destroy the coking properties of the sample, a result which has led some observers to conclude that hygroscopic water is essential to coking, which is manifestly incorrect, as the tertiary coals, which contain the largest quantity of hygroscopic moisture, will not coke, owing to the proportion of humus derivatives being largely in excess of the resin bodies.

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We have already seen that the ash of coal represents mineral constituents present in the sap of the original plants, or derived from the surrounding strata during the formation of the coal, whilst nitrogen, derived from the proteid bodies in the vegetation, is always present to the extent of 1 to 2 per cent., and is probably mostly borne by the humus bodies in the coal, which also are the most likely to be the carriers of the organic sulphur which has been clearly proved to be present, the bulk of the sulphur, however, being in the form of pyrites produced by sulphides from the reduction of mineral sulphates reacting upon iron salts infiltrating in solution into the coal measures.

Many classifications of coal have been suggested, some based on their chemical, some on their physical, and others on their coking properties, and of the latter the most generally adopted is that suggested by Gruner, in which he tabulates bituminous coals into five classes, and although Schondorff, Muck, and others have shown that it is not applicable to all kinds of coal, still this criticism applies to all classifications that have been proposed :—

In the third class the action still has continued with further concentration of the resin bodies, hydrocarbons and residuum, with the result that the former bodies are so increased in comparison to the humus and residuum that a good coke results, although, for reasons that will be discussed when speaking of coking processes, it is rather too porous and bulky.

In the fourth class the proportion of resin and hydrocarbon bodies has reached the right ratio as compared with the humus and residuum, and the best coking coal is obtained. Bituminous coals of the kind classified by Gruner may, therefore, be looked upon as an agglomerate of humus and the degradation products of these bodies down to carbon, luted and protected by resin bodies and their derivatives; steam coals and anthracite as the degradation products of humus which has nearly completed its decomposition owing to the small quantity of resin bodies in the original vegetation; cannel coal as consisting mainly of resin bodies, which, having been in a semi-fluid condition, have mingled with the earthy matter in contact with it, so obtaining the high ash found in many kinds.

			Carbon.	Hydrogen.	Oxygen.
1.	Dry coal	Long flame and non-coking	75–80	4·5–5·5	15·0–18·5
2.	Fat gas coal	Coke porous and brittle	80–85	5·0–5·8	10·0–13·2
3.	Semi-fat or furnace coal	Good coke, but porous	84–89	5·0–5·5	5·5–10·0
4.	Coking coal	Best coke	89–91	4·5–5·5	4·5– 5·5
5.	Lean coals and anthracite	Non-coking	90–93	3·0–4·5	3·0– 4·5

This arrangement shows not only the coking properties, but also the changes in composition which the coal undergoes, the concentration of carbon and reduction in highly-oxidised bodies.

In the first class we have the dry coals, yielding large volumes of gas and liquid products on distillation, and these, as might be expected, most resemble the lignites, and share with them the property of non-coking or binding together of the residue on carbonisation.

This is due to the fact that the humus-like bodies are still present in much larger quantities than the resinic compounds and hydrocarbons, and as on distillation they leave no binding material in the residue, the resinic bodies cannot supply enough to give more than a friable mass.

In the second class of coals altered conditions of temperature, pressure, and time have led to further decompositions of the humus bodies, and the resinic constituents and hydrocarbons having increased in ratio by concentration, a point is reached at which coking takes place, although not of a satisfactory character.

In putting forward this theory as to the composition of coal, I wish it to be distinctly understood that by the terms "humus" or "resin" bodies, I do not imply any one distinctive compound, but merely bodies of this character, the humus bodies all containing a percentage of hydrogen from 5 per cent. downwards, whilst the resin bodies all contain a percentage of hydrogen above 5 per cent. If it is once admitted that coal is a conglomerate of the kind I have indicated, it explains all those obscure points which no other theory touches—such as why with two coals of almost identical composition and of high oxygen content, one should be a coking and the other a non-coking coal; the reason being that in the one the high oxygen content is due to humus bodies, which will not coke owing to the low pitch-forming nature of the hydrocarbons, whilst with the other the oxygen is due to resin bodies which are essential to good coking.

In 1898 Anderson and Roberts,* as the result

* *Jour. Soc. Chem. Ind.*, 1898, 1019.

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of a long research upon the chemical properties of Scotch coals, came to the conclusion that a considerable part of the organic matter in coal consists of a complex compound comparatively rich in nitrogen and also containing sulphur, and that there is also present resinous material, whilst the remaining constituents are composed of degradation products of the original carbohydrates of the coal plants—a theory which, in its essentials, agrees very well with my views on the subject.

During the present year Burgess and Wheeler* have published the results of a series of experiments upon the distillation of coals at various temperatures, which lead them to conclude that coal contains two types of compounds of different degrees of ease of decomposition. The most unstable decomposes below 750° C., and yields on distillation the paraffin hydrocarbons and no hydrogen; the other decomposes only at or above 750° C., and yields hydrogen only, or possibly hydrogen and oxides of carbon. The latter they suppose to be a degradation product of cellulose, the former to be derived from the resins and gums from the coal plants, and the authors consider that the difference between one coal and another is determined by the proportion in which these two types exist in the coal.

In 1907, whilst working on the "Coalite" process, I found that the possibility of making this smokeless fuel was dependent upon the fact that if the temperature of distillation of coal was kept at 400° C. to 500° C., all the liquid and all the heavy hydrocarbon products of its decomposition capable of forming smoke were evolved, the volume of gas amounting to from 4,000 to 5,000 cubic feet, whilst the coke still contained a residual compound that required a temperature of 700° C. to 1000° C. to decompose it, when a volume of gas nearly equal to the original yield was evolved, consisting of hydrogen and methane with small quantities of oxides of carbon, and it was this volatile compound which gave the coalite its ease of ignition and flaming combustion. This I stated in a Cantor Lecture at the Royal Society of Arts in 1908, when giving the principle of the manufacture of coalite, as follows: "Success can be achieved only by dropping the temperature to a scarcely visible heat (400° C), and when this is done the coke may be kept at it for almost any period without driving out those volatile hydrocarbons that give easy ignition and a smokeless flame."†

* *Chem. Soc. Jour.*, 1911, 649.

† *Journal of the Royal Society of Arts*, 1908, LVI. 853.

It is evident that this more resistant volatile residue is the body which Burgess and Wheeler consider a degradation product of cellulose, which on heating "yields hydrogen alone."

The error into which these observers have fallen in supposing that hydrogen alone is evolved is due to the fact that their assumptions have been based upon the composition of the gases evolved during distillation at successive stages of temperature and the use of very small quantities of material.

Had Messrs. Burgess and Wheeler used a larger quantity of coal and distilled out everything that would come over up to 600° C., and had then distilled the residue at 800° C. to 900° C., they would have found that at these temperatures the residues were still yielding a certain proportion of methane, which had been one of the most characteristic products of decomposition from the time when the vegetation first began its conversion into peat.

Another great mistake made by Burgess and Wheeler lies in supposing that of the two classes of compounds present in coal, one decomposes below 750° C., whilst the other decomposes only at or above that temperature and yields hydrogen only.

All the evidence that can be adduced shows that when a coal undergoes destructive distillation, all the hydrocarbons, together with the resin and humus constituents, undergo decomposition at a temperature certainly well below 700° C., and that, as the liquid and gaseous products distil out, they leave behind their less volatile residues as a pitch, which lutes together the carbon particles and forms soft coke, whilst as the temperature rises above 750° C., the pitch residue decomposes, yielding hydrogen, carbon monoxide, and methane as gases, whilst the carbon residue from the pitch binds the residual mass into coke, and it is this residual pitch that Burgess and Wheeler have mistaken for a primary constituent of coal.

It is clear, however, that (putting detail on one side until our knowledge has been broadened by experience) the answer to the question as to what is the composition of coal—whether the answer is derived from a consideration of the actions taking place during its formation and of the substances from which it was derived, or is obtained from analytical data, as was done by Anderson and Roberts, or from the products of distillation, as has been attempted by Burgess and Wheeler—must be that coal is a conglomerate of humus and its degradation products with the resinic bodies and their derivatives.

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INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, December 14th, 1911, Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., Vice-President of the Society, in the chair.

The Chairman, in introducing the reader of the paper, said he had no doubt many of those present were already well acquainted with Dr. Jenkins's name and fame. The author had had a long experience in superintending the sea fisheries on the western coast of England, and a few years ago he was deputed at the instance of the Government of Bengal to advise and assist them in inquiries into the possibility of deep-sea fishing principally in the Bay of Bengal. He was therefore exceedingly well informed, and better able than most people to give information upon the subject which he was bringing to the notice of the members of the Society in his paper.

The paper read was—

THE FISHERIES OF BENGAL.

By J. Travis Jenkins, D.Sc., Ph.D.,
Superintendent of the Lancashire and Western Sea Fisheries.

Recent investigations into the fish and fisheries of the Province and Bay of Bengal date from the appointment of Sir (then Mr.) K. G. Gupta, in July, 1906, to inquire into and report on the fish resources of Bengal. Previously but little was known of the possibilities of fishing in India; its gigantic rivers and estuaries and its vast areas of potential trawling ground had never been examined from the standpoint of modern commercial fishing.

Sir K. G. Gupta, in the first place, reported on the conditions prevailing in Bengal, and afterwards visited Europe and America. The results of his tour were incorporated in a second report, which contains not only a narrative of his observations, but also a summary of his recommendations for the improvement of the fisheries of Bengal. As these reports* are available for reference, it is not proposed to discuss them in any detail here. Numerous valuable recommendations were made in the second report, and if these had been properly carried out, there can be little doubt that a permanent improvement in the fish supply of the Province would have resulted.

The four principal suggestions made by Sir K. G. Gupta were:—

1. An exploration of the deep-sea and estuarine resources of the province.

2. A study of the migrations and the spawning-grounds of the hilsa.

3. The cultivation of the species of Bengal carp (catla, rahu, etc.).

4. The establishment of a permanent organisation for the development and control of the fisheries of the Province.

Sir K. G. Gupta retired from the Indian Civil Service in February, 1908, and the control of the fishery investigations was transferred to an officer with the title of "Commissioner of Fisheries," under whose management they remained until March, 1910.

Early in 1908 I was approached by the India Office and invited to go to Bengal to act as "Adviser to Government on Fishery Matters," and in October I proceeded to Calcutta for a period of eighteen months for that purpose. Meanwhile a second-hand steam trawler (the "Golden Crown") had been purchased by the India Office for the survey of the Bay, and this vessel left England in February, 1908, with an agreement for a two years' fishing voyage in the Bay of Bengal. After sundry alterations in Calcutta, which materially affected the fishing capacity of the vessel, she started on her first fishing voyage on June 10th, and at the entrance to the Eastern Channel encountered the bad weather of the onset of the S.W. monsoon. Fishing was, however, persevered with in Balasore Bay and elsewhere. My first voyage in this trawler was in November, 1908, to the Arakan coast, and subsequently I took part in voyages to all parts of the Bay visited by the "Golden Crown," so am able to speak from personal experience of the possibilities of trawling. Steam trawling is probably the most successful modern method of fishing in temperate waters. At any rate, out of about seven and a half million pounds' worth of fish landed in England and Wales during 1909, no less than six million pounds were trawl-caught fish. A trawl is a conical or bag-shaped net, which is "shot" from the steamer's side and is towed along the bottom astern while the steamer moves ahead at a slow rate of speed (usually from three to four miles per hour). Commercial trawling is only possible up to depths of about 100 fathoms, so that our experiments in the Bay of Bengal were confined to a somewhat narrow area near the coast. In all, the "Golden Crown" made twenty-eight voyages to the Bay,* and only on one occasion was the weather so bad that fishing was impossible. This was in November, 1909, off the Arakan coast, when a cyclonic storm was encountered. During all these voyages trawling was tried in depths varying

* Reports on the Results of Inquiry into the Fisheries of Bengal and into Fishery Matters in Europe and America. By K. G. Gupta, Calcutta. Bengal Secretariat Book Depot. 1908. Price 2*d.*

* See Appendix I.

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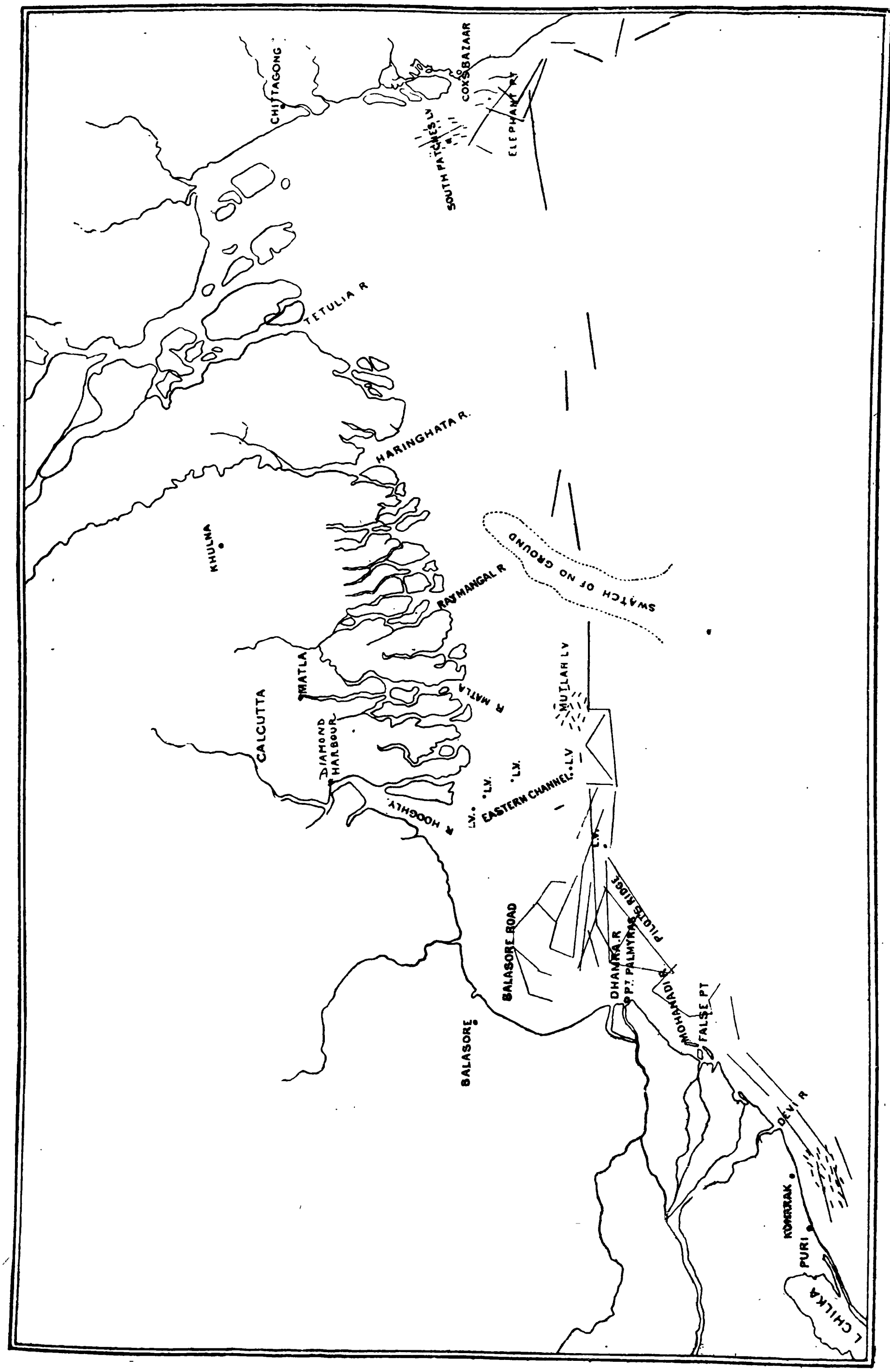

SKETCH CHART SHOWING GROUNDS TRAWLED OVER BY THE "GOLDEN CROWN"
(June–December, 1908).

from 14 to 70 fathoms, from Calingapatam, in the Presidency of Madras, to Akyab, on the Burmese side. From time to time interim reports on the work of the trawler appeared in the *Calcutta Gazette*, and for the details of the voyages these should be consulted.* One ought, perhaps, to explain here that a steam trawler engaged in fishing for commercial purposes trawls during the whole of the twenty-four hours, and this rule was followed on the "Golden Crown." All modern trawlers are fitted up with two sets of fishing gear in readiness for immediate use, one on the port side and the other on the starboard side, so that as soon as one net is hauled, the other may be shot. As noted above, the alterations made to the "Golden Crown," on her arrival at Calcutta, made her starboard gear useless, with the consequence that when we were on the fishing grounds, frequent annoying though unavoidable delays occurred. Whilst surveying unknown grounds, it is impossible to avoid damage to the net, and all this damage had to be repaired before the net could be used again. Even a Commissioner of Fisheries could see the inutility of fishing with a net which had a large hole in it. Many hours were spent idly at sea while all hands were repairing the net, and this should be taken into account in estimating the weight of fish caught per day's trawling. Moreover, in shooting the net, account has to be taken of the direction of wind and tide, and it will be obvious even to landsmen that with a vessel only capable of using her port gear, much time would be lost in manœuvring her into position for shooting and hauling.

As a rule, the "Golden Crown" made four hauls a day—at daybreak, at noon, just before sunset, and at midnight. For the last haul the acetylene gas installation on board was used but, even so, the sorting of specimens was attended with some difficulty. The largeness and frequency of the hauls made it practically impossible for any scientific work to be done on board. Typical specimens of fish and the various groups of invertebrates were preserved, and the localities from which they were obtained were noted. On arrival at Calcutta, the collections were transferred to the Museum, where they were arranged into groups, so that each separate group might be sent to a specialist for report. Broadly speaking, the "Golden Crown" trawled over four fairly distinct areas. These are:—

1. Commencing near the Mutlah Light Vessel (off the entrance to the river of that name), and extending to the westward past the entrance to the Eastern Channel (leading to the Hooghly) down to the Pilot's Ridge Lightship.

2. Off the Arakan coast from the South Patches Lightship, at the entrance to Chittagong, to Oyster Island, in the vicinity of Akyab.

3. The coast of Orissa from the mouth of the Devi river to the entrance to Lake Chilka.

4. The coast of the Ganjam district of the Madras Presidency from Ganjam to Santapilli Lighthouse (in Vizagapatam district).

In the first area, the bottom of the sea consists of an extremely fine and soft mud. Here, in order to trawl successfully, the vessel had to be kept going at a fairly good rate of speed, as otherwise the net would have become immovably imbedded in mud. This mud is, of course, derived from the deposit of particles brought down by the rivers of the Gangetic delta. A large number of the empty shells of a species of dentalium (a scaphopod mollusc) is met with here. Peculiar round balls of mud are brought up in the trawl, and these, when opened, are found to have a species of mussel (alive) inside. Generally speaking, on these muddy grounds the invertebrate fauna is scanty, and the vertebrate fauna (fish) quite distinctive and in marked contrast to any of the other areas. Gigantic skates and rays, huge ferocious congers, enormous ground-sharks and saw-fish are the most characteristic forms. The "Bombay Duck," a few soles, and an occasional shoal of pomfrets comprise the more valuable commercial species of this area. In the second area the ground varies considerably. Near the South Patches Lightship it is muddy; further to the south this becomes replaced, in depths from 8 to 17 fathoms, by fine glittering sand with patches of shells at intervals. Off St. Martin's Reef, in from 10 to 13 fathoms, fishing was conducted on grounds consisting of shells and fine gravel. Between St. Martin's Reef and Oyster Island the trawl brought up fossiliferous rocks of Miocene Age, specimens of which were handed over to the Geological Survey of India. As the "Golden Crown" was not provided with gear suitable for trawling on rocky ground, these localities had to be abandoned before they had been properly explored, though I am fairly certain that, with proper nets, trawling could be successfully carried on in this area.

The predominant feature of the bottom in the third area was sand, which, in depths of 25 fathoms and upwards, was replaced by mud.

* *Vide Calcutta Gazette* Supplements, March 24th, June 16th, August 4th, October 13th, 1909.

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Off the Black Pagoda (Konarak) there is a reef of a recent conglomerate of sand and decomposed shells, where on one occasion the trawl was lost. Off the mouth of the Devi river turtles were unusually abundant, no less than six being taken in a single haul of the trawl. This region turned out to be a better trawling ground than either of the two previous areas, the proportion of fish which would be classed by the trade as "prime" being relatively high.

Sparoid fish (bearing a superficial resemblance to the "John Dory" of home waters), mackerel and horse-mackerel were the most typical fish of this area.

In the fourth area, off the Ganjam coast, the bottom in shallow water was sand, changing into mud in greater depths. In the southern part of this area the ground became more varied. Off Gopalpur, in depths of 24 fathoms, enormous numbers of shells of a species of mollusc were found interwoven into rock-like masses with a sponge. The more solid nature of the ground here furnishes a holding place for gigantic fan-like corals (*Antipatharia*). The fish of this area were quite distinctive, and for the first time true coral reef denizens were captured.

The "Golden Crown" Fish.

The question of the kinds, quality, and quantity of trawl-caught fish in the Bay of Bengal is one of the greatest commercial importance. Obviously, the scientific names of the different species would convey little or no idea to most people of the various characteristics—appearance, flavour, and digestibility—which render fish marketable or otherwise. Consequently, it is necessary to take the names given to the fish by the European crew of the "Golden Crown," with the minimum of explanatory notes to make them intelligible.

In some cases the crew of the trawler adopted local names (not always correctly), and in other cases utilised the common names of European fish, on account of some superficial resemblance, or they even invented entirely new names for fish which were quite unlike any common European marine species.

The local names adopted for the purposes of classification were bhekti, bummaloh, topsi, and pomfret. The pomfret is a well-known species, and needs no description. The bummaloh is a kind of marine catfish, and is well known to Anglo-Indians as the "Bombay Duck." The topsi was not real "topsee much" of the estuaries (*Polynemus paradiseus*), but two allied species (*P. indicus* and *P. plebeius*). The bhekti of the "Golden Crown" was not the bhekti (*Lates calcarifer*) of Bengal, but comprised two or more forms, notably a species known locally as the datneh (*Chrysophrys datnia*), and several percoid forms. Of the names applied to fish in the Bay which have been adopted on account of the presumed similarity to European species, the chief are whiting, herring, gurnards, halibut, conger, prawns, skate, soles, lobster, rock salmon, and cod. Of these the whiting, gurnard, and rock salmon are structurally very dissimilar to the European forms of the same name. The *Gadidæ* (cod, whiting, etc.) are only represented by one minute form in Indian waters, and the so-called whiting of the "Golden Crown" included a number of different species of scienoids, a family represented occasionally in British waters by the "meagre." The cod were really large perch-like forms (*Serranidæ*). The rock salmon was *Otolithus maculatus*, a scienoid with a spotted surface, not altogether unlike a salmon in appearance; it is perhaps hardly necessary to add that there are no indigenous *Salmonidæ* in Indian waters.

The "gurnards" were siluroids (catfish), for the most part belonging to the genus *Arius*. It is not surprising that the crew of the trawler were very wide of the mark in this guess, as siluroids are quite unknown in the home markets. The name was undoubtedly given on account of the hard bony plates protecting the head, which are found in both forms.

Of the true flatfish (*Pleuronectidæ*), the "halibut" was *Psettodes erumei*, which is more like the flounder than the halibut in appearance. True soles are absent in the Bay of Bengal, though allied forms of the genera *Cynoglossus*, *Synaptura* and *Plagusia* were by no means rare. The "conger eel" was *Murænesox cinereus*, and the "skates" invariably sting-rays. The herring and mackerel were sufficiently like the home species to justify their names, as were also the prawns and lobsters. The unintelligible divisions of "red flats," "small flats," included all those numerous species of different genera which bore a superficial resemblance to the "John Dory."

The table at the end gives the details of the fish captured by the "Golden Crown" (see Appendix II.). From this summary it will be seen that the average catch for the whole period was 26·6 cwts. per day's trawling. For comparison, a statement is appended showing the average catch in cwts. per day's absence from port of first-class English steam trawlers during

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1909, that being the last year for which statistics are available*:—

Region.	Cwts. of Fish per Day.
White Sea	59·88
Iceland	43·61
Rockall	39·51
Faroe	34·94
North of Scotland	26·50
West of Ireland	25·82
Southward of Ireland	25·81
Westward of Scotland	23·88
Biscay	17·28
North Sea	16·95
Bristol Channel	14·95
Irish Sea	14·38
English Channel	13·61
Portugal and Morocco	8·58

As regards weight of fish caught, Indian waters are roughly equivalent to those of the North of Scotland. In making this comparison, it must be noted that the figures given for the "Golden Crown" are cwts. per day's fishing, whereas those for the English trawlers are per day's absence from port. On the other hand, most of the English trawlers referred to, especially those visiting the more remote fishing grounds, are much larger than the "Golden Crown," are fitted with more varied and powerful gear, and are run on strictly commercial lines. On several occasions the "Golden Crown" made very large hauls, nearly, and in some cases over, a ton weight of edible fish (excluding sharks) for a haul lasting from four to five hours. For instance:—

Voyage 18.—February 11th, 1909. Off Eastern Channel entrance. Pilot ship bearing N.W. by N., about seven miles. Haul made at noon. Gurnards, 676 lb.; mackerel, 427 lb.; pomfrets, 273 lb.; whiting, 131 lb.; congers, 100 lb.; skate, 35 lb.; bhekti, 32 lb.; halibut, 12 lb.; soles, 5 lb. Total, 1,691 lb.

Voyage 24.—September 29th, 1909. Gopalpur, bearing N.W., depth 25 fathoms. Haul made at 5 p.m. Gurnards, 560 lb.; whiting, 460 lb.; small flats, 375 lb.; bhektis, 320 lb.; prawns, 260 lb.; red flats (*Pagrus spinifer*), 70 lb.; skate, 60 lb.; cod, 30 lb.; conger, 10 lb.; mixed, 10 lb. Total, 2,255 lb.

Voyage 25.—October 16th, 1909. Santapilli light bearing W.N.W. about sixteen miles away, the depth being 28 fathoms. Haul made at 5.30 p.m. Bhektis, 835 lb.; small flats, 530 lb.; whiting, 450 lb.; gurnards, 400 lb.; prawns, 240 lb.; pomfrets, 8 lb. Total, 2,463 lb.

Voyage 27.—November 27th, 1909. Black Pagoda (Konarak), bearing N.½E., depth 15 fathoms. Hauled at 11.30 p.m. Prawns and whiting, 480 lb. apiece; gurnards, 350 lb.; small flats, 340 lb.; bhektis, 65 lb.; skate, 20 lb.; pomfret, 20 lb.; soles, 12 lb. There were also two turtles taken this haul. Total weight (excluding turtles), 1,767 lb.

Practical Results of the "Golden Crown's" Investigations.

Indian officials who had experience of Indian waters previous to 1908 had emphatically pronounced in favour of the enormous wealth of fish-life to be found there. Lieutenant-Colonel Maxwell, C.I.E., who was formerly in charge of Burmese fisheries, stated that in his opinion "wealth beyond the dreams of avarice" awaited the persons who first had the courage to exploit the fisheries of India in a modern fashion. Lieutenant-Colonel Alcock, formerly Superintendent of the Indian Museum at Calcutta, and naturalist on the Royal Indian Marine Survey Ship, the "Investigator," was equally confident. He wrote: "The sea fisheries of the Bay of Bengal are of a value well-nigh incalculable. That they are unknown, uncared for, and unappreciated, is unfortunately true; but it is equally true that they will prove a mine of wealth to whoever may have the enterprise to exploit them and the tenacity of purpose to work them in the face of the apathy and incredulity that at present exist regarding them."

Before a successful trawling company can be established, there are many things to be considered. Some of the problems were solved by the "Golden Crown" investigations; others remain to be dealt with in the future.

One of the most important factors for consideration is the climate. Can fishing be carried on regularly in the Bay of Bengal by modern steam trawlers in all weathers? The experience of the "Golden Crown" enables us to answer this most important question in the affirmative, so that it is possible to secure a regular and constant supply of fish for the markets. Trawling was, as a matter of fact, carried on in every month except May, and there can be no doubt that if the "Golden Crown" had not been laid up for repairs, she would have gone out that month as well.

On reference to the table (see Appendix II.), it will be seen that only one voyage out of twenty-eight was entirely unproductive. On this voyage (No. 26) a cyclonic storm was encountered on November 14th, 1909, off the Burmese coast near Akyab. A lot of water was shipped, the provisions were spoilt,

* Annual Report of Proceedings under Acts relating to Sea Fisheries for the year 1909. Board of Agriculture and Fisheries. Cd. 5874. Price 2s. *Vide* p. lviii. Table B.

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and the trawler had to return to Calcutta without any fish. Although she was by no means as seaworthy as the most modern type of trawler, the "Golden Crown" trawled right through the S.W. monsoon of 1908, and during 1909 she trawled in September, October, and November, when exceptional weather was encountered.

The climate also affects the possibility of keeping fish fresh. It was proved by the "Golden Crown" investigations that it is possible to land sea fish in a fresh condition in Calcutta from places as far distant as Akyab and Santapilli, and, moreover, this fish had undergone no deterioration in quality, appearance, or flavour. The fish, when caught, were washed in clean sea water, and then (with the exception of the soles, which were gutted) placed in the hold in ice in an ungutted condition.

As will have been gathered from the preceding remarks, the quantity of fish captured per day's trawling compares favourably with many British fishing grounds, in spite of the handicaps under which the "Golden Crown" laboured. The fish to be obtained in the Bay are, for the most part, of excellent appearance and taste, and should command a quick sale in the Calcutta and up-country markets. Even the coarsest varieties could be disposed of to the poorer classes.

The only inedible varieties are the sharks and the saw-fishes, and even in these forms the fins and livers could be utilised. In some of the larger saw-fish I dissected, the liver alone weighed over a hundredweight. The weight of sharks and saw-fish is not included in the table in the Appendix, and only on two occasions is the weight of fins given. It may not be out of place to mention here one or two other matters that would have to be considered very carefully by any company that proposed to exploit the Bay with steam trawlers. The greatest difficulty is undoubtedly pilotage. As most of you know, Calcutta is situated a considerable distance from the open sea, and is approached by a river—the Hooghly—which is one of the most difficult in the world to navigate. No vessel is allowed to move in the river after dark, and when the tide is unfavourable, the journey from Calcutta to the open sea frequently takes two days. The pilotage dues are necessarily heavy. Moreover, even when moored in the river opposite Prinsep's Ghat at Calcutta, the discharge of fish is attended with difficulties which have to be seen to be realised. For these reasons, I am inclined to recommend the claims of Diamond Harbour in preference to Calcutta as a trawling base. Diamond Harbour is merely a tidal creek, with no facilities at present for trawling, but it possesses numerous advantages over Calcutta. In the first place, it is much easier of approach from the sea, some of the most difficult shoals including the celebrated "James and Mary," being situated above it. A master of a steam trawler, after some experience of the locality, ought to be able to pilot his vessel without assistance.

Diamond Harbour is connected with Calcutta by a branch line of the Eastern Bengal State Railway, so that perishable goods could be rapidly transported there. Coal and fresh water could be brought down by launches or country boats, whichever was cheaper. Land for building purposes could be obtained at a cheaper rate than in Calcutta, and there should be no difficulty about coolie labour. Coal and water are both cheap, but ice is expensive, and it would certainly pay any trawling company to make their own ice. There is no Customs duty on fresh fish, and the harbour dues (if any) would be very moderate. There are no laws or regulations restricting trawling in any manner in the Bay of Bengal, and none will probably ever be required. There would be no opposition to trawling by native fishermen, as the natives do not fish in the open sea except to a very limited extent off the Madras coast. The fish merchants in Calcutta might, and probably would, attempt to boycott trawl-caught fish, since it would tend to interfere with the large profits they at present enjoy. Hands for deck and engine-room work can be obtained at cheap rates, but in my opinion no trawler could fish successfully in the Bay of Bengal with less than two Europeans on board.

Scientific Results of the "Golden Crown's" Investigations.

On board the trawler at sea it was impossible to do any work beyond the sorting of specimens into groups and their preservation in formalin or spirit. The collections were taken to the Indian Museum and there prepared for identification. The influx of a large number of species of fish and marine invertebrates, some of the former of huge size, threw a great deal of additional work on to the Museum staff. It is with great pleasure that I take the opportunity of recording my warmest thanks to the Museum staff, not only to Dr. Annandale, but to all his assistants for the help they afforded.

The necessity for the revision of the fishes of India is one of the points which the collection

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of the "Golden Crown" (and others made in various parts of India by the Museum staff) has brought into prominence. Day's work was completed in 1878, since when large collections have been made, new species have been described, and doubts thrown on the correctness of some of Day's descriptions. As regards the "Golden Crown" fish, certain groups were worked out by Dr. Annandale. The cartilaginous families of the skates and rays, saw-fish and ground-sharks, were revised and brought up to date. Of bony fish, the flatfish (*Pleuronectidæ*) and the *Plectognathi* and *Pediculati* have been dealt with.

The cartilaginous forms (*Batoidei*), such as skates and rays, are, for the most part, species which live on the bottom of the sea, and are consequently commonly caught in the trawl. In his report Dr. Annandale* says:—

"Of the fifty-three distinct species of *Batoidei* here recognised as occurring in Indian seas, no less than thirty-three have been taken during the past year (1908–9) by the "Golden Crown." Of the remaining twenty, seven probably live only in water deeper than that in which the operations of the fishery steamer have been conducted, while at least four (the members of the family *Ceraptopteridæ*) are surface forms, and would not usually be taken in the trawl. In the list there are twenty-one specific and two varietal names not to be found in Day's volume in the "Fauna of India," or there regarded as synonyms. Of these, nine belong to species described within the last few years by Alcock or Lloyd, and, with two exceptions, taken in deep water by the "Investigator," while twelve are here recorded for the first time, or have recently been recorded for the first time in the Records of the Indian Museum. A new genus, five new species and a new variety, are described in this report."

Of the *Plectognathi*,† sixty-one species are known from Indian Seas. Of these, seventeen only were taken by the "Golden Crown." This is because the *Plectognathi* are reef-haunting species for the most part, and were only found in any variety towards the southward limits of the trawler's explorations. In this group a new species of *Triacanthus* has been described by Mr. Chaudhuri from the "Golden Crown" collections. Of the *Pediculati*, out of twenty-five species, twenty are deep-sea forms. Only three were taken on the trawler, but one of these was a new species.

* See Memoirs of the Indian Museum, Vol. II. No. 1. Report on the Fishes taken by the Bengal Fisheries' steamer "Golden Crown." Part I. Batoidei. By N. Annandale. Calcutta. Baptist Mission Press. May, 1909.

† See Memoirs of the Indian Museum, Vol. III. No. 1. Report on the Fishes taken by the Bengal Fisheries' steamer "Golden Crown." Parts II., III., and IV. By Annandale and Jenkins.

A revision of the flatfish (plaice and soles) belonging to the *Pleuronectidæ* collected in the Sunderbans on the "Ila," at sea on the "Golden Crown," and elsewhere in India by the Museum staff, revealed the existence of five new species.

For particulars of the various groups of invertebrates, the Records and Memoirs of the Indian Museum should be consulted. A bibliography of the papers dealing with the scientific work on the "Golden Crown" collections has been prepared and will be published in a paper* on the fauna of the Bay, which is at present in the press.

THE INVESTIGATIONS IN THE SUNDERBANS.

Although I repeatedly applied† to the Commissioner of Fisheries for the use of a launch for the exploration of the fisheries of the rivers and estuaries of the Sunderbans, it was not until the end of August, 1909, that a vessel was placed at my disposal. On three separate occasions in 1909—*i.e.*, in August, November, and December—the "Ila," a steam launch of the Salt Department, was employed on a fishery survey of the Sunderbans. This vessel, though well adapted for journeys in confined waters, was not built for fishery work, and the very confined deck space, the obstructions aft, as well as the absence of a steam winch, all hindered our investigations. Had a preliminary survey been possible in the cold weather of 1908–9, much valuable information as to the local conditions would have been obtained, and suitable fishing gear could have been ordered for extended operations in the following year. As it was, we had to do the best we could with a few nets which were only suitable for fishing in the open sea.

The nets used were a fish-trawl and a shrimp-trawl attached to a twenty-foot wooden beam, and herring and mackerel drift-nets. Various adaptations were tried with a view of suiting these nets to the local conditions, and although the results were not on the whole encouraging, a great deal was learnt of the peculiarities of the local fish and the possibilities of their capture on a commercial scale provided suitable gear was employed. The crew of the "Ila," who were without exception natives of India, very quickly learnt to handle the trawl and drift-nets, and I am pleased to be able to bear witness to their intelligence, adaptability, and willingness.

The first voyage was to the districts of the 24-Parganas and Khulna, and lasted from

* In the Records of the Indian Museum.

† The first occasion being on October 31st, 1908.

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August 20th to 29th, 1909. Both trawl and drift-nets were tried in the creeks and the large rivers, the depths in the latter being anything from 6 to 10 fathoms. This time of the year, at the end of the rainy season, the whole country was flooded, and, owing to the currents in the rivers being at their strongest, fishing was more difficult than in the following voyages, which were carried out in the cold weather. In no instance were large hauls made, but still some interesting specimens were captured. On August 25th, when fishing with the shrimp-trawl off Morrelganj, a good haul of soles, bholas (*Sciœnoides pama*), and siluroids was obtained. These fish were taken at the bottom of the river, at a depth of 10 fathoms, a place inaccessible to the local fishermen's nets. The soles were quite unlike any previously met with in Indian waters, being much more slender than any known species. These fish were subsequently described as two new species of *Cynoglossus*.

The second voyage was confined to the district of the 24-Parganas, and lasted from November 10th to 21st, and on this occasion much better results were obtained, in spite of the obvious unsuitability of the nets for creek and channel fishing. Good hauls were made with fixed nets in a creek near Chennia, and the shrimp-trawl yielded fair quantities of shrimps, prawns, and bummaloes in 4 to 5-fathom water in this vicinity. The sea face would appear to be the most promising locality in the Sunderbans in the cold weather, and with suitable nets Fraserganj ought to be capable of commercial exploitation. The third voyage was also to the districts of 24-Parganas and Khulna, and lasted from December 5th to 16th, 1909. Similar experiments were tried, and the nets were, as far as possible, adapted to suit the local conditions. There can be no doubt that a properly-managed scheme for the development of the fisheries of the Sunderbans would be successful, the chief drawbacks at present being lack of fast transport and the fact that fishery operations are not sufficiently systematic and carried out on a large enough scale. The limited survey of the "Ila" proved that the Sunderbans are well stocked with fish of economic importance.

The estimated area of the Sunderbans in the Province of Bengal is 5,700 square miles, and obviously it was impossible to explore the fishery resources of this vast region in thirty-five days. Every variety of waterway is met with, from gigantic rivers several miles in breadth, with a fierce rush of tide, to tiny stagnant back-waters where the decaying vegetation gives off a pronounced odour of sulphuretted hydrogen and where fish life is an impossibility. The banks of rivers and creeks are alike composed of soft mud, except near the sea face, as at Fraserganj and the mouth of the Bungarah river, where a firm sandy beach is seen. In the unsettled tracts, dense impenetrable jungle grows right down to the water's edge, and in the tidal regions the stems and roots of the trees are densely encrusted with barnacles. This has probably given rise to the idea which is prevalent in Calcutta—that there are vast quantities of oysters in the Sunderbans. No edible mollusca of any kind were seen at the places visited by the "Ila." The water of the Sunderbans rivers and creeks varies from perfectly fresh through increasing degrees of salinity, till at the mouths of the larger rivers it approximates to that of sea water, though water of the salinity of the open sea was never encountered. Naturally the fish fauna varied with the salinity, depth, and other environmental conditions.

At the commencement of the rainy season the famous hilsa (the Indian shad) makes its annual journey from the sea to its spawning grounds in the higher reaches of the Ganges; and in certain parts of the Sunderbans, such as Khulna, there is an extensive fishery for this fish. Coarse fish, such as skates, rays, and sharks, did not appear to be very abundant. On the other hand, the catfish (*Siluridœ*) were very frequently taken. In fresh-water species of macrones (*Air*) and in brackish water *Osteogeniosus*, *Arius*, and *Pangasia* were caught. The development of the young in the mouth of the male parent was observed in two species of siluroids. In November, when fishing with drift-nets at Fraserganj, a number of specimens of *Osteogeniosus militaris* were captured, and in the mouths of the males a series of fertilised eggs were seen. These eggs showed the stages of development from the recently fertilised to that in which the yolk was almost completely absorbed. Apparently, even after development is complete, the young seek shelter in the mouth of the parent fish, since in the Culputooa River, on August 22nd, a specimen of *Arius jatius* was taken in the shrimp-trawl, in which three young ones were so sheltering.

Other valuable fish met with in the Sunderbans are the bummaloh, or Bombay duck, the bhekti, the datneh, the bhola (*Sciœnoides pama*), the cuja bhekti (*Sciœna cuja*), and the grey mullets, all of which would be considered prime fish in England.

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A summary of the fishing "log" of the "Ila" is printed as an Appendix (No. III.). As in the case of the "Golden Crown," collections of typical fish and invertebrates were made and deposited in the Indian Museum.

The question of the development of the Sunderbans ought not to be considered apart from the other coastal fisheries of Bengal, and consequently a brief reference must here be made to the fisheries of Puri and Lake Chilka.

Puri and Lake Chilka.

At Puri the fishing is carried on by Telugus in the fine weather by means of masula boats, in the S.W. monsoon with catamarans. The masula net is really a gigantic seine. One end of the seine is attached to a rope, which is left with a party on shore. The net itself is placed in the masula boat, and paid out gradually as the boat makes a semicircular sweep beyond the surf. When the whole net is paid out, the boat comes ashore with the rope attached to the other end of the net. The net is then hauled up on the beach, the fish being captured in a pocket at the tail end. Very large hauls are frequently made by these Telugu fishermen in this manner. In rough weather the catamarans are used. One is hardly justified in applying the term "boat" to the four pieces of wood which, when lashed together, constitute the catamaran. Apparently the net used is a sort of drift-net, but I was unable to see this net at work. There is practically no attempt to preserve or cure fish for the market apart from merely drying them in the sun. This drying is customary both for small sprat-like fish (kanagurta) and for the larger mackerel (kokile). The fish are simply spread out singly on the sand and allowed to dry in the sun. Apparently no salt or other preservative is employed.

It would be difficult, if not impossible, to improve on the methods of fishing employed by these Telugus. They are admirably adapted for such a coast, where there is a heavy surf even with north-easterly winds. The absence of any suitable harbour or roadstead renders the introduction of the type of vessel used in England for inshore fishing impossible.

In Lake Chilka the methods of fishing are, briefly, two in number. Firstly, there is a seine net, the burra jal; and, secondly, there are fixed engines, stake "nets," or, rather, bamboo enclosures, in which the fish are trapped. Here, again, it is doubtful whether much, if any, improvement on the local methods of fishing can be devised. Some time previous to my visit to Chilka some European (Norwegian) fishermen attempted to exploit these fisheries, but without success.

Probably if any more efficient methods were adopted, the result would be a depletion of the fish stock in the lake and a permanent diminution of the supply. The burra jal has an enormous sweep, and must be sufficiently destructive in the confined waters of the lake. The method of fishing is, allowing for the different conditions, similar to that of the Telugus at Puri. The fish, however, instead of being landed on the shore, are driven up two narrow lanes of netting, and baled out with baskets. Of the fixed instruments there were numerous varieties, ranging from the enormous bamboo enclosures on Nalbano Island to small semicircular enclosures consisting of a number of basket-like traps.

Unlike the Telugus at Puri, the Ooriyas of Lake Chilka have a very fair idea of curing fish. The fish are split open down the middle of the back, the entrails removed and the inside is then sprinkled over with salt and placed out to dry in the sun, sometimes on bamboo stages erected on the lake, sometimes on the ground outside the fishermen's huts. Some of the larger fish were cut up into slices before salting. The question of the encouragement of a trade in salted fish is hardly one that can be entered into here. It was, however, considered carefully by the Fishery Board, but apparently the practical difficulties were insurmountable; at any rate, nothing had been done up to early in 1910. Although, in my opinion, there is a great future for what I may call the fresh fish trade in Bengal, it must not be understood that this would necessarily exclude the preservation of fish. It would be rash to generalise from the experience of a few months only, but from what was seen at Lake Chilka, it is more probable that a trade in salted fish would spring up gradually, provided the duty were remitted, than in any other way. The introduction of European methods of curing might prove of advantage in some of the larger centres, but one would prefer to see the local fishermen develop their own resources with duty-free salt.

Development of Sunderbans and other Local Fisheries.

The chief problem to be solved in the development of the fisheries of Bengal is the question of transport. There can be no doubt (1) That the supply of fresh fish in Calcutta and up-country markets within a day's journey is quite inadequate to meet the demand; and (2) That there is a large quantity of edible sea and

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estuarine fish of the highest quality available within easy reach of Calcutta.

Since this fish can be purchased from the local fishermen far cheaper than it could be caught by any other means, there seems to be no reason for introducing European or any other methods of fishing, except in places like Fraserganj in the Sunderbans, where there is no community of indigenous fishermen and an abundant supply of fish.

Fresh fish always commands a quicker sale and a better price than any cured fish, and consequently I believe that any company which might be formed to develop what is only done now spasmodically—a trade in fresh fish preserved in ice for the Calcutta market—ought to be very successful, if at all reasonably managed. In my report to Government on the result of the estuarine investigations carried out on the "Ila," I pointed out the reasons why the development of the estuarine fisheries should pay, and the lines along which such development should proceed. An estuarine fishery would possess several advantages over any other:—

1. A much smaller capital would be required than in the case of a steam trawling company. To equip and maintain a small fleet of motor launches would cost far less than a corresponding number of steam trawlers. These launches would be mainly used for transport, which is the chief difficulty in the way of development of the fisheries.

2. The risk of casualties and delays in the supply to the Calcutta market consequent on the weather would be much less than in the case of deep-sea trawlers.

3. The development of the estuarine fisheries would be independent of the importation of European labour, and would consequently cost much less than steam trawling, where, in my opinion, Europeans could never be dispensed with. In an estuarine fishery it is rather by improving and modifying the local methods of fishing than by introducing foreign methods which may prove unsuitable to local conditions, that success is to be anticipated.

4. The taste and good qualities of the estuarine fish are already well known to the population of Bengal, whereas sea fish are not so well known, and are certainly less appreciated. In the estuaries there are fish suited to the taste and means of all classes of the population. The bummalohs, bhektis, cuja bhektis, mullets, shrimps, and prawns compare favourably with the best of fish anywhere, while the siluroids, gobies, and others would suit persons of moderate means. When one considers the class of fish found on the tables of well-to-do up-country residents at present, it seems almost incredible that no attempt has been made to develop on a large scale the possibilities of the Sunderbans and other coastal fisheries of Bengal.

The Spawning of the Hilsa.

It is alleged that the hilsa of Bengal (the Indian shad) is less abundant than formerly, and several efforts were made to locate its spawning grounds, presumably with a view of attempting to increase the supply by artificial propagation if that were found to be practicable. Meanwhile it should be noted that, in the neighbouring Government of Madras, the Conservator of Fisheries (Mr. H. C. Wilson) had made and published certain observations* on the spawning of the hilsa in the Coleroon and Cauvery rivers during the monsoon period of 1908. These observations were made at an anicut where the fish were "held up" on their way to the spawning grounds from the sea. These ripe fish were, therefore, not obtained on the natural spawning grounds. The diameters of the ripe eggs are not given. The spawning places and habits of the American shad (*Clupea sapidissima*) are now well known, and artificial hatching of this fish is extensively practised in the United States. Nothing is known of the details of the spawning of the European shad (*Clupea alosa* and *C. finta*). In Bengal it appears that the hilsa move up the rivers in the rainy season, and down towards the sea on their return journey from December to February. As they are full of "roe" when they move up, and are "spent" when they return, it follows they are anadromous—*i.e.*, spawn in the rivers. Wherever possible, adult hilsa were examined in 1909, and a careful search was made along the banks of the rivers with a fine-meshed net for the fry or larvæ. Specimens of the adult fish were purchased in the Calcutta markets, and subsequently visits were made to Sara Ghat, Rajmahal, Khulna, Bagherhat, Monghyr, and Kooshtea, in the order named. At each of these places adult hilsa were examined. No ripe females were discovered, but ripe males were examined at Rajmahal, Monghyr, and Kooshtea. At Monghyr a spent female was obtained on September 23rd; a single specimen of the fry of hilsa was also obtained at this locality. It was six centimetres in length. So that it appears as if the hilsa spawned at any rate above

* See Government of Madras. Revenue Department. G.O. No. 1219. May 5th, 1909. Artificial propagation of the hilsa in the Coleroon.

Monghyr. Reports of the young of hilsa should be verified by careful examination of specimens, as it is easy for an unpractised hand to mistake these for quite another species (*Clupea chapra*). Unfortunately, owing to circumstances over which I had no control, the investigation into the spawning habits of this interesting and valuable species was suspended at a time when it appeared probable, or, at any rate, possible, that its spawning grounds would be located.

The Culture of Carp.

The culture of the Indian species of carp, such as the catla and rahu, was attempted by the Fishery Department. A station was established at Barh, at a considerable distance from Calcutta, where the water-supply was obviously not as abundant as in Lower Bengal. Subsequently a station was started near Calcutta. Considerable sums were expended in excavating a tank or tanks at Barh, and pumping had also to be provided for. The net result was that no water could be supplied for the carp to live in, much less breed in.

A proposal to introduce legislation to prevent the sale or capture of the young of carp below a specified size was introduced to the Fishery Board by the Commissioner of Fisheries, but, as it was unanimously opposed, it was rejected.

The Establishment of a Permanent Department of Fisheries.

The future administration of the fisheries of Bengal was naturally one of the most important questions to which Sir Krishna Gupta's attention was directed, and in the thirteenth section of his second report to Government his recommendations are set forth. Had these recommendations been adopted, with an efficient permanent official to see them properly carried out, there can be no doubt that by now Bengal would have a Fisheries Department which would serve as a model for the rest of India. Presumably the consideration of the fisheries of India as a whole was outside Sir Krishna Gupta's terms of reference; otherwise it is certain that his scheme would have been of even greater effect if applied to India as a whole and not restricted to the Province of Bengal.

Practically every civilised country with a seaboard has a department for the organisation, development, and control of the fisheries, and some nations spend large sums annually on these matters. In the British Islands the value of the fish when first landed cannot be less than eleven million pounds sterling per annum.* and by the time it has reached the inland markets its value is considerably enhanced. As a matter of fact, fish is practically the only foodstuff now exported from these islands. We find in England, Scotland, and Ireland permanent central organisations with large powers entrusted with the duty of supervising both sea and inland fisheries. The organisation in Scotland, the Scottish Fishery Board, seems to have appealed to Sir Krishna Gupta, and he advised a board on similar lines for Bengal. With the sole substitution of India for Bengal, I am heartily in agreement with this recommendation. What is wanted is a central organisation similar in plan, but naturally on a smaller scale, to the Geological Survey of India. In the case of the fisheries, this department should be placed in charge of a permanent official, who should have an expert knowledge of fish and fisheries, and who should report to a small central board. Such a board should consist of five members representing the maritime provinces—Madras, Bombay, Bengal, Eastern Bengal and Assam, and Burma—one representative of the remaining provincial governments, and should meet under the chairmanship of an official representing the supreme Government. The duties of the board would consist mainly in the preparation of annual budgets and in the receiving and discussing, and, where advisable, the adopting of suggestions made by their expert official. The official—who might rank as an inspector-general—should be allowed a wide margin of freedom of action. It is only reasonable that Government, through their Board, should decide as to how much money they can devote from year to year for the improvement of the fisheries, but it is unreasonable to bring out to India an expert, and then hinder him at every turn.

It would be the duty of the Fishery Department, in the first place, to collect and publish statistical and other information relative to the present position of the fisheries of India, on the lines of the admirable reports which already exist for the Province of Bengal * and Eastern Bengal and Assam.†

Where it can be clearly shown that local fisheries have declined in recent years, the cause of the decline should be investigated and remedial measures proposed, and, if found practicable, put into operation.

A revision of the volumes on "Fish" in the

* In 1909, the last year for which official statistics are available, it was £11,012,568.

* K. G. Gupta, *op. cit.*

† Report on the Fisheries of Eastern Bengal and Assam. By K. C. De. Shillong. 1910.

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"Fauna of India," prepared by the late Dr. Francis Day, is urgently needed, and this work could only be properly undertaken by such a department as I have indicated, working in conjunction with the staff of the Indian Museum at Calcutta. No single individual could now perform this work unassisted; it is rather a matter for a small group of expert systematists.

The training of his subordinate staff should also be one of the first duties of the permanent head of the department. As Sir K. G. Gupta says: "It would also be desirable to send young men to Europe and America to study fishery matters under competent teachers." A very commendable object, but only after a fairly comprehensive preliminary training in India, and always provided the students set out with a definite programme of work, to which they should be expected strictly to adhere. It is useless to send students abroad unless they are fully conversant with the local conditions in India, with the families of fish and their European or American relatives. Otherwise, how is the student to devote his attention to those subjects which are likely to be of practical assistance to him when he returns to India to take up his vocation? The overlapping that must ensue if any extended scheme of investigation is undertaken by a provincial Government is well illustrated by what happened in the case of Bengal. The marine investigations—which were financed by Bengal—were carried on quite as much off the coasts of the three neighbouring provinces of Madras, Eastern Bengal and Assam, and Burma, as they were off the coasts of Bengal and Orissa. Similarly, the solution of the problem of the spawning grounds of the hilsa is as important to Eastern Bengal and Assam, Madras and the United Provinces, as it is to Bengal. At the present moment you have isolated investigations proceeding in various provinces, and apparently without any attempt at co-ordination. It would be as reasonable for each province to have its own Geological Survey. The collection of statistical information relating to Indian fisheries is also a desideratum.

In conclusion, one can only say that it must be obvious even to any one who has lived a very short time in India that the fisheries of India are neglected, and it is the duty of the Government to take stock of an asset of considerable value, and further to encourage in every way in its power the development of a natural source of food supply, the potentialities of which are enormous.

APPENDIX I.

The dates of the "Golden Crown's" voyages and the localities visited are summarised below:—

No. of Voyage.	Date.	Locality.
1.	June 13th to 23rd, 1908	Pilot's Ridge and Balasore Roads.
2.	July 6th to 13th, 1908	Near Elephant Point, Arakan Coast.
3.	July 31st to August 5th, 1908	Off False Point, Orissa Coast.
4.	August 19th to 22nd, 1908	Off Pilot's Ridge Light Vessel.
5.	August 24th to September 3rd, 1908	Arakan Coast.
6.	September 13th to 19th, 1908	Arakan and Orissa Coasts.
7.	September 24th to 27th, 1908	Orissa Coast.
8.	October 1st to 5th, 1908	Orissa Coast, between Konarak and Puri.
9.	October 11th to 15th, 1908	Orissa Coast, between False Point and Konarak.
10.	October 22nd to 29th, 1908	Orissa Coast, between False Point and Konarak.
11.	November 11th to 18th, 1908	Arakan Coast.
12.	November 21st to December 1st, 1908	Orissa Coast, off Konarak.
13.	December 4th to 13th, 1908	Orissa Coast, between Konarak and Puri.
14.	December 17th to 22nd, 1908	Near Mutlah Light Vessel.
15.	December 30th, 1908, to January 7th, 1909	Arakan and Orissa Coasts.
16.	January 11th to 19th, 1909	Off Eastern Channel, entrance to River Hooghly.
17.	January 23rd to 29th, 1909	Off Eastern Channel, entrance to River Hooghly.
18.	February 9th to 15th, 1909	Off Eastern Channel, entrance to River Hooghly.
19.	February 19th to 27th, 1909	Orissa and Madras Coasts, Konarak to Gopalpur.
20.	March 5th to 15th, 1909	Orissa and Madras Coasts, down to Baruva.
21.	March 30th to April 7th, 1909	Ganjam Coast.
22.	April 15th to 24th, 1909	Orissa Coast.
23.	September 6th to 16th, 1909	Orissa and Ganjam Coasts.
24.	September 20th to October 2nd, 1909	Mainly off Ganjam Coast.
25.	October 13th to 25th, 1909	Ganjam Coast, down to Calingapatam.
26.	November 10th to 18th, 1909	Arakan Coast.
27.	November 24th to December 3rd, 1909	Off Konarak. Pilot's Ridge and Eastern Channel.
28.	December 9th to 17th, 1909	Off Puri. Ganjam Coast and Eastern Channel.

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APPENDIX II.

DETAILS OF FISH CAUGHT BY THE "GOLDEN CROWN" FROM OCTOBER 1ST, 1908, TO END OF DECEMBER, 1909.

(All weights expressed in pounds.)

	Voyage.																					Total.
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Days actual fishing	5	4	5	4	6	7	4	3·6	6·5	4·75	5	3·75	7·75	5	6·75	7·5	6	8·5	Nil	7	4·5	
Kind of Fish :—																						
Whiting	2,150	3,710	4,900	809	3,108	4,502	2,749	882	3,914	1,878	2,323	735	3,366	3,695	3,612	6,451	2,515	5,795	No fish. A cyclone was encountered.	5,990	2,750	
Gurnards	1,450	1,540	1,555	600	2,688	4,568	1,688	1,163	4,759	4,054	3,315	2,357	2,273	2,821	5,585	7,338	2,810	3,920		4,880	2,740	
Prawns	1,400	3,250	2,100	—	1,680	1,699	369	59	314	80	350	389	941	469	2,449	6,105	1,920	3,110		770	815	
Rock Salmon	700	1,150	515	1,020	410	217	191	84	256	327	403	56	—	—	—	—	—	—		250	—	
Small Flats	700	300	590	—	1,680	2,811	291	607	790	331	972	1,246	2,357	1,827	1,636	4,932	1,750	5,190		1,690	1,533	
Conger Eels	500	954	490	1,189	40	904	464	92	4,381	3,663	3,836	1,056	226	585	6,447	1,233	205	527		1,452	1,375	
Pomfrets	500	275	470	111	672	165	112	236	1,935	1,070	2,775	351	146	185	580	259	45	385		373	148	
Bummaloes	450	350	315	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		100	—	
Bhekti	410	520	840	555	2,050	814	526	21	277	440	159	755	4,243	5,422	2,965	3,259	4,130	3,247		630	820	
Skate	400	760	468	247	220	738	1,964	634	1,556	1,738	2,820	1,230	2,519	1,946	1,748	845	430	1,258		3,477	868	
Soles	—	230	101	26	—	—	—	45	401	228	178	64	59	139	294	35	—	—		223	71	
Halibut	—	—	—	—	60	122	112	39	348	105	194	84	320	281	171	87	—	55		50	86	
Red Perch	—	—	—	—	—	—	—	174	—	—	161	—	—	—	—	—	—	13		—	—	
Red Flats	—	—	—	—	2,604	1,415	—	77	—	—	—	319	1,007	749	—	540	1,144	690		95	217	
Cod	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	571	268	283		—	65	
Mixed	—	—	—	—	756	240	108	149	89	—	503	—	340	143	249	—	55	—		—	—	
Sharks' Fins	—	—	—	—	—	—	—	—	—	—	—	241	100	—	—	—	—	—		—	—	
					No.		No.		No.	—	—			No.	No.					No.		
Turtles	—	1,200	—	77	5	—	1	—	6	—	—	—	80	2	3	—	—	—		16	4	
Totals	8,660	14,239	12,344	4,634	15,968	18,195	8,574	4,262	19,020	13,914	17,989	8,958	17,977	18,262	25,736	31,660	15,272	24,473		19,980	11,488	311,605

No records were made of the weights of fish caught during the first seven voyages.

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APPENDIX III.

Fishing "Log" of Launch "Ila."

The route taken by the "Ila" is, as briefly as possible, recorded below, together with the places at which fishing operations were carried out, the nature of the net used, and the kind of fish caught, if any:—

Date.	Route.	Fishing at	By	Fish caught.
	First voyage, 24-Parganas and Khulna Districts.			
August 20th	Prinsep's Ghat to Mud Point.			
,, 21st	Mud Point to Bosondheer abad.	Bosondheer abad	Drift-nets	Nil.
,, 22nd	Bosondheer abad *viâ* Kaliganj to Chandkhali.	Burra Kaligatchia.	Shrimp-trawl	Topsee, bummaloes, shrimps and prawns.
		Nubaspore near Kaliganj.	Ditto	Ditto.
		Culpoottooa River.	Ditto	Prawns, few small fish.
		Ditto, second haul.	Ditto	Bholas, siluroids, bummaloes, gobies.
,, 23rd	Chandkhali to Khulna	Seepsah River	Ditto	Few shrimps.
		Khulna	Drift-nets	Nil. Had to haul immediately to avoid fouling native nets.
,, 24th	Khulna to Creek near Rupsah River.	Rupsah River	Shrimp-trawl	Nil. Net got foul with propeller and badly torn.
,, 25th	Above Creek to Morrelganj and then to Bagherhat.	Morrelganj	Ditto	Soles (cynoglossus), bholas and siluroids.
		Bagerhat	Drift-nets	Bholas.
,, 26th	Bagherhat to Pussur River (Creek near Chandpai).	Ditto	Ditto	Bhekti.
		Creek near Chandpai.	Ditto	Nil; net badly torn.
,, 27th	Chandpai to Khulna	Chandpai	Ditto	Fensa.
,, 28th	Khulna to Botiaghatta	. . . .	. . . . . .	No fishing. Coaling.
,, 29th	Botiaghatta to Bosondheer abad. Bosondheer to Calcutta *viâ* Mutlah and Canal.	Bosondheer abad	Drift-nets	Siluroids.
	Second voyage, entirely in 24-Parganas District.			
November 10th	Prinsep's Ghat to Chennia	Chennia	Drift-nets	Bhekti.
,, 11th	Remained at Chennia	Ditto	Ditto	Good haul. Siluroids, bhekti, sele, cuja bhekti, with *Chirocentrus dorab*, and *Scatophagus argus*.
,, 12th	Chennia to Fraserganj	Ditto	Shrimp-trawl	Good haul of shrimps, prawns, and bummaloes.
		Fraserganj	Drift-net	Large mullets, siluroids.
,, 13th	Fraserganj	Ditto	Shrimp-trawl	Few shrimps and small fish. Had to haul soon owing to strong wind and tide.
	Ditto	Ditto	Drift-net	In creek. Siluroids.

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APPENDIX III.—*continued.*

Date.	Route.	Fishing at	By	Fish caught.
		Second voyage, entirely in 24-Parganas District—continued.		
November 14th . .	Fraserganj to Kankondighee (for coal).	Jhobar Deol (near Kankondighee).	Shrimp-trawl	Shrimps and small fish; moderate haul.
		Kankondighee .	Drift-nets .	Sole, bhekti, clupeoids, sharks.
„ 15th .	Kankondighee to Matla	Matla . . .	Drift-nets .	Nil. Very strong current.
„ 16th .	Matla to Basanti F. S. .	Matla River . .	Shrimp-trawl	Good haul. Shrimps, bummaloes, pangash.
		Hooghly nullah	Ditto . .	Moderate. Shrimps, bummaloes, pangash.
		Basanti . . .	Drift-nets .	Sole (2 feet 2 inches), goby (1 foot 5 inches).
„ 17th .	Basanti F. S. to Guasuba River (Creek below Lot. 156).	Matla River . .	Shrimp-trawl	Moderate haul. Shrimps and bummaloes.
		Guasuba River .	Ditto . .	Moderate haul. Shrimps and bummaloes.
		Ditto . . .	Drift-nets .	Sole, cuja bhekti.
„ 18th .	Guasuba River to Kankondighee (for coal).	Kaikal Maree .	Shrimp-trawl	A few shrimps and bummaloes.
		Kankondighee .	Drift-nets .	No fish.
„ 19th .	Kankondighee to Ellplot	Ditto . . .	Ditto . .	Do.
		Creek near Ellplot.	Shrimp-trawl	Moderate haul of shrimps and bummaloes, etc.
		Ditto . . .	Drift-nets .	Siluroids and one cuja bhetki.
„ 20th .	Ellplot to Fulta . . .	Creek near Ellplot.	Drift-nets	Bhekti, cuja bhekti and
	Ditto	Ditto . .	Ditto .	*Lutjanus johnii* and *Toxotes jaculator.*
„ 21st .	Fulta to Calcutta . .	Channel Creek .	Shrimp-trawl	Few shrimps and bummaloes.
		Third voyage, 24-Parganas and Khulna Districts.		
December 5th .	Prinsep's Ghat to Mud Point.	. . . . . .	. . . . .	Unsettled weather, heavy rain, disturbed sea.
„ 6th .	Mud Point to Sonadigheee.	Sattermukhee River.	Fish-trawl .	One large sole and a few *Trygon* and *Scatophagus.*
		Sonadighee . .	Drift-nets .	Siluroids.
„ 7th .	Sonadighee to Basanti F. S.	Khultollee Creek	Fish-trawl .	Net badly torn. Foot-rope fouled with anchor; no fish.
		Basanti F. S. .	Drift-nets .	Only one globe fish (*Tetrodon fluviatilis*).
„ 8th .	Basanti F. S. to Seepsah River (Khulna district).	Kaliganj . . .	Fish-trawl .	Net badly torn; no fish.
		Near Kaliganj .	Shrimp-trawl	Towed at surface. Shrimps, small fish, such as *Barbus* and *Engraulis.*
		Menus River .	Ditto . .	Towed at surface. Shrimps, fensa, pangash, *Ambasis*, *Tetrodon.*
		Seepsah River .	Ditto . .	Few shrimps and small fish.
„ 9th .	Seepsah River to Khulna for coal, and then to Shelah F. S.	Creek near Shelah.	Ditto . .	Good catch of shrimps, also bholas, soles, *Scatophagus* and *Tetrodon.*

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APPENDIX III.—*continued.*

Date.	Route.	Fishing at	By	Fish caught.
Third voyage, 24-Parganas and Khulna Districts—continued.				
December 10th .	Shelah F. S. to Mirgamari River (*viâ* Pussur River).	In Mirgamari River (below plot 248).	Shrimp-trawl	Few shrimps, prawns and small fish, *Chorinemus*, pangash, *Gobius sadanundis*.
			Drift-nets .	Bummaloes, bhola, and *Trichiurus*.
„ 11th .	Mirgamari River to mouth of Bungarah River.	Bungarah River	Shrimp-trawl	Shrimps and bummaloes Moderate haul.
		Ditto . .	Fish-trawl.	Nil.
		Mouth of Bungarah River.	Shrimp-trawl	Good haul. Shrimps, prawns and bummaloes.
„ 12th .	Mouth of Bungarah River to Shelah F. S.	Shelah F. S. . .	Ditto . .	Few shrimps.
„ 13th .	Shelah F. S. to Khulna (for coal).	. . . . . .	Drift-nets .	Nil.
„ 14th .	Khulna *viâ* Kaliganj to Sorabkatti.	Sorabkatti (24-Parganas).	Ditto . .	Nil.
„ 15th .	Sorabkatti to Surajbuggi	Near Sorabkatti, 24-Parganas.	Shrimp-trawl	Net badly torn; a large tree in it. Strain caused beam to break. A few bholas, bummaloes, pangash, and other siluroids in cod end.
		Surajbuggi . .	Drift-nets .	Sole, mullet, cuja bhekti.
„ 16th .	Surajbuggi to Calcutta (*viâ* Matla).	Ditto . . .	Fish-trawl .	Nil.

DISCUSSION.

Sir K. G. Gupta, K.C.S.I., in opening the discussion, said that those who had listened to the paper need not be told that he felt very much interested in the fisheries of Bengal. He was very glad to take part in the discussion, because while he was wandering about Great Britain for the purpose of obtaining information with regard to fisheries, he came across many competent experts, amongst them the author. He then made a mental note that if an opportunity occurred he would like Dr. Jenkins to be sent out to Bengal. That opportunity was subsequently given him, and to the great benefit of the new Fishery Department of Bengal Dr. Jenkins's services were utilised, although, he was sorry to say, only for a very short time. Those who had not studied fish could have no idea of the fascination which the subject exercised over those who took an interest in it. Personally, he took to the fisheries question rather late in life. It was not until within two or three years of his retirement from the Indian Civil Service that he was called upon to take up the inquiry to which reference had been made. When the offer was made he was utterly amazed, because he knew nothing of fish. He had not even done anything with the rod and line. However, as those who had been in India knew very well, the civilians were supposed to know everything, from administering a district, dispensing justice, collecting revenue, looking after sanitation, to inspecting schools. He therefore thought it was his duty not to refuse, and thereupon he took leave and began studying the very elements of the subject. Having acquired a sort of elementary knowledge, he started on his inquiry, and having done with Bengal he was allowed an opportunity of visiting the great fishery departments of this country, the Continent, the United States, and Canada. It was surprising what a large amount of useful information could be gathered within a short time; and with the generous help of various officials in all the countries he visited he was able to get a fair insight into the working of their fishery departments. He did not pretend to have any scientific knowledge at all; his business was with the administration, to see how the fisheries in Bengal could be conserved and developed. Many false ideas were held in regard to the matter. It was very often said that Indian fishermen knew their business very well, and it was impossible to teach them anything.

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The same remark used to be made with regard to the Indian peasant. When agricultural improvements were mooted, it was at once stated that the Indian peasant knew everything, and being poor he could not adopt Western or improved methods. But all those ideas had changed. There was now in India a great central Agricultural College; the Provinces had their separate colleges, and the old exploded idea that the Indian peasant could not be taught had disappeared altogether. He was in hopes that the same thing would happen with regard to the fisheries. To his mind, land and water were equally productive of human food. When he was in Bohemia he visited a very big estate of one of the princes of Hungary, and there, along with the cultivation of crops and the rearing of cattle, he found immense tanks devoted to the culture of that valuable fish, carp. The manager of the estate told him that from an acre of fish two or three times more profit was obtained than from the same amount of land grown with crops. The author had confined his paper more to the sea and estuary resources of Bengal, but in addition to these there were immense water surfaces in the rivers of lower Bengal, which could be utilised more largely for the cultivation of fish. As an example of the scientific methods of cultivation, he was told, when visiting the United States, that before 1877 carp was an unknown fish in America. About 1877 or 1878 the Fishery Department introduced a few dozen carp, and within a few years, with proper care and cultivation, they spread all over the country, so that that particular species of fish did not now require any further cultivation. In the City of New York alone, more than a million pounds of carp were now consumed every year. What was particularly required in Bengal was conservation and development. The present methods of catching were too destructive, and both the fishermen and the owners of private waters had yet to learn that, in order to get the full benefit of an abundant fish supply, it was necessary to conserve and develop their resources. Every civilised country had been obliged, for the sake of maintaining a proper and adequate supply, to establish close seasons, and to open hatcheries, and so on. Those were methods of very great importance, and if the fresh waters of India were not to be denuded of fish, recourse must be had to those measures. It was easy to imagine what would have become of the salmon supply in this country if a closed season had not been inaugurated, and strict regulations promulgated prohibiting capture at certain seasons of the year. There was no such regulation as yet in India. In times gone by when the population was smaller, the natural supply was, perhaps, sufficient, but now the population was increasing while the area of fresh-water fish supply was gradually diminishing. If the fresh-water fish resources of India were to be fully utilised, recourse must be had to measures that had been found so very useful and productive in other countries. So far, both the landlords and fishermen of India had not realised that point. All fishery legislation was very much resented by fishermen all over the world, because they did not know their own interests. They had to be educated; and that was one of the principal duties of a Fishery Department. He was glad to say the Fishery Department in Bengal had been put on a permanent footing, although on a very limited scale. It was to be hoped, however, that as soon as public opinion began to recognise the great importance of the subject, the activities of the department would be gradually amplified, and that full results would be obtained. With regard to sea fisheries, the author had naturally confined his paper to the results he obtained from trawling, but the sea yielded its wealth not merely by trawling but by other means of capture. The surface fish was not caught by trawls; the herrings and mackerel were caught in different ways by drift-nets. The possibilities of Indian sea fisheries with regard to surface fish had not yet been exploited. There were only two points in the paper he wished to criticise. In the first place the author stated that before his (the speaker's) report nothing had been done in regard to fishery matters in India. He did not think that was quite correct, because, apart from the labours of men like Day, Thomas, and others, within recent years his friend, Sir Frederick Nicholson, had done a great deal in Madras to develop the fisheries of that Province. It was due to Sir Frederick to say that in his quiet way he had been steadily working to develop the fisheries of Madras, and had succeeded in a large measure. In the second place, he did not agree with the author that one fishery board should be established for the whole of India. India was a very vast country, and if a central board were established, how would it be possible to get the representatives of the different Provinces together? In the present days of decentralisation one must not talk of a central board at all. Many of the Inspector-Generalships that were created not many years ago were disappearing. Some had already gone, others were trembling in the balance; so that if anyone suggested a central board of the kind mentioned, the idea would be entirely discounted. Personally, he thought that, after all, it would be best to have provincial boards. The circumstances of each Province were so different, especially with regard to fishery matters, that it would not be of any advantage to have one board controlling the whole country. Of course the time would come, as it had in the United States, when there would be a central office regulating fishery matters all over the country, while each of the several Provinces had their separate Fishery Department, but that day was far distant. In the meantime they ought to be satisfied if each Province which had large fresh-water fisheries as well as sea fisheries had a separate department working properly and adequately. He desired, in conclusion, to express his high appreciation of the work done by the author, and of his very excellent paper, which had been illustrated by such beautiful slides.

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SIR JAMES BOURDILLON, K.C.S.I., said that many of those present who lived in Calcutta some years ago would remember the energetic gentleman who edited the *Planters' Gazette*, Mr. Harry Abbott, and it might be within their recollection that he started a company for supplying Calcutta with fresh fish, and to search after the mine of treasure to which the author had referred. It would be of great interest if Dr. Jenkins could state what the result of that venture was.

THE CHAIRMAN, in proposing a cordial vote of thanks to the author for his exceedingly interesting and valuable paper, said he was sure everyone recognised the fact that Dr. Jenkins's work was neither easy nor light. Anyone who had travelled through the Bay of Bengal during a north-east monsoon would know that a voyage in a trawler at such a time was anything but a pleasant experience. He was also sure that those present sympathised with the author in the difficulties he experienced in obtaining a proper vessel in which to conduct his experiments. Personally, he was ignorant of the reasons which led to the alterations in the trawler which was eventually placed at his disposal, but he could quite understand that they might not have been intentional or even carelessly caused, but that they were the result of want of means and ability. Such things did interfere seriously with the desire of experts to get on with their work. He made that plea because, being an old official, he knew that one was sometimes accused of obstruction when there was no such feeling in one's mind. He fully agreed with the author's statement that the whole subject of deep-sea and estuarial fishing turned on the question of transport. From that point of view Dr. Jenkins made the very valuable suggestion that if anything was to be done in the way of establishing a deep-sea fishing company, Diamond Harbour and not Calcutta must be the central point for the work. The reasons the author gave for that opinion appealed very strongly indeed to anyone who knew the geography and the local circumstances. The author had given a great amount of valuable information with regard to the method of fishing adopted, and the amount of fish which might be obtained out of the sea and also out of the Sunderbans, but he had not said anything about the inland fishing. Anybody who had been on the Megna and Pudda in the rains knew that an enormous number of boats fished daily, and caught fish by the ton. He thought he was also right in saying that for several months of the year the Eastern Bengal Railway ran a daily fish-train from Goalundo down to Calcutta, and that Calcutta was very largely supplied with fish, during the hilsa season at all events, from the rivers to the north of it. Fishing went on all the way up to Monghyr, and further up still, the Ganges being covered with little fishing-boats at night. That was a source of supply to the country, and how far that would come into competition with the larger sources of supply to which the author had referred was a point which ought to be considered. Another point touched upon by the author was the salting of the fish. Dr. Jenkins spoke of the necessity of salt free of duty being supplied for the fish industry, a point which, personally, he quite understood and appreciated. As Dr. Jenkins stated, the whole question of fresh-water fish supply depended upon transport, and the difficulty was overcome if the fish could be preserved. Some years ago, just before he left India, an experiment was tried, on the Madras side, of giving a fish company salt free of duty in order to try to preserve fish. It would be of great interest if the author could state how that project eventuated. He knew a great deal of difficulty was experienced in ensuring that the salt which was given for those fish purposes should not be used in ordinary business transactions. He did not see how it was possible to overcome that difficulty, but even if that was the case it mattered very little. It was perfectly possible to arrange that the loss would be small, and it was a subject that need not be considered in comparison with the additional food supply which would thereby be obtained. Sir Krishna Gupta had touched upon the possibility of carrying out the author's suggestion for a co-ordinated authority all over India to control, teach, and exploit fisheries. Personally, he thought it might be possible to combine the author's and Sir Krishna Gupta's points together, namely, to have provincial control with provincial superintendents for each Province, who might be brought together to sit as a board two or three times a year. That would probably to a certain extent meet the objection that had been raised. He admitted, however, that the financial difficulties which Sir Krishna referred to were paramount at a time when some of the Inspectors-General were being abolished and some of them were hanging by the hairs of their heads. On the one side scientific and even army work was being cut down for the sake of economy, while on the other side they were threatened with an enormous expenditure on new capitals and new provinces; and it was not very likely that a small thing of the kind referred to, although it did add largely to the food supply of the million, and made two blades of grass grow where one grew before, would be very easily granted.

SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., in seconding the vote of thanks, said:—His title to take a part in the discussion on the most instructive and most attractive paper with which Dr. Travis Jenkins had favoured them was,—that while in Bombay he had taken a great interest in the fisher-folk, Christians and Hindus, about Bombay, and along the coast of the Concans down to Savantvari, and the River Rachol in the Goa territory; that while serving for over thirty years in the India Office he had kept in touch with questions relating to the Indian fisheries, "the most fishful of all in the world" [as Solinus says of those (sardines, etc.) of Sicily], so far as they came

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before him officially; and that directly he left the India Office he was asked to advise some gentlemen who were contemplating the formation of a syndicate for the express purpose of organising a company for the development of the miraculously prolific fisheries of the Bay of Bengal and the Sunderbans, which alone are capable of supplying cured fish of over one hundred edible, and of these from ten to twelve greedily comestible, species. He wished that his son, Mr. Frank Birdwood, when invited by the Chairman to speak on Dr. Travis Jenkins's paper, had done so, for what he would have had to say of the projected syndicate and company would have been most suggestive, and, in spite of the abandonment of their tentative adventure, most inspiring. The Government of India, both in London and at Calcutta, were most considerate, and indeed helpful; but the difficulties then presented by the Salt Tax, which may be said to have now practically disappeared, and by the land regulations, prevented his friends proceeding further with their enterprise. It was some time subsequent to this period that he became acquainted with Sir Krishna Govinda Gupta's masterly report, of which they had now all heard so much for themselves from Dr. Travis Jenkins; and began to hear of Dr. Travis Jenkins's own good and truly redoubtable researches, with the "Golden Crown," in the Bay of Bengal, which were sure to bear the very best good fruit, and that in the immediate future. The Government of India were to-day more ready than ever to meet stable and honest adventurers with regard to modifications of the Salt Tax for the single-eyed purposes of fish-curing; and they might well remove it altogether, for from the physiological and medical points of view, it was a sheer iniquity; and they might readily lift off the burden of it from the shoulders of the people of India if they would but hold on to the opium tax; this tax being wholly paid by the people of China, and opium, from a physiological and medical point of view, being an essential dietary "adjuvant" to the due nourishment and health of all hard-working vegetarians, like the 200,000,000 agriculturists of India and Farther India. In any case, either the Salt Tax should be modified, and to abolition, at least for the fisher-folk of India, or the Government should be prepared and eager to assist alike Indian and English capitalists who might be found willing to reorganise the fisheries of India on a wider, and more thorough, and more productive basis; which could not be attempted by conscientious private capitalists without State aid, in some shape or other, at the start. Give them this assistance, and the harvest of the Indian Ocean would embrace the whole wide world for its market—its "Forum piscarium." These were the conclusions he (Sir George) had come to after his small, but well-manifest experience as an interloping "City man," and all that he had heard that evening from Dr. Travis Jenkins, and Sir Krishna Govinda Gupta confirmed him in them.

But a further "stone of stumbling" in the adventure was the way in which the English fisheries' experts, and his own adventuring friends, industrial and commercial, and the State officials in London and in Calcutta, would persist in looking at the problem before them from the English point of view, and not only the English officials, but the very Indian ones, as in the instance here, and this instant evening, of Sir Krishna Govinda Gupta. This was the very "rock of offence," this incorrigible English egotistry of ours, that had prevented the "Burma Ruby Mines" from ever paying an adequate dividend on their capital; as he (Sir George) had said would be the case some fifteen years ago in that very room. English experts were sent out, and English machinery, and the whole adventure was schemed on the basis of English experience: whereas the working of the rich ruby mines of Burma by the Burmese themselves ought first to have been studied by our experts on the spot, and the confidence of the native miners in the Company thus secured; when at once we would have been able to introduce improved methods, if required, for increasing the output of rubies, and to-day be reaping the rich reward of our sagacity, and superior [scientific] skill. But how should Englishmen be blamed for their industrial egotism when we found an Indian official, of the highest ability, and who had attained to the highest positions in the service of the Imperial Government of India, telling us here that on being appointed to the sphere of duties, detailed in his notable report, which marked the opening of a new and most hopeful era in the history of the Indian fisheries,—telling us that instead of first studying them all round the coasts of India, he at once went off to study the fisheries of England, and Scotland, and Wales, and Canada, and the United States,—anywhere, wherever we are all English, and Sir Krishna Govinda Gupta the most English of us all! It made him (Sir George Birdwood) feel as if he was the only pristine Hindu left, all marooned in a bitterly cold world! It was, indeed, all a-piece with the attitude taken up by us toward Indian literature and art until about thirty years ago, and still continued toward Indian education, and agriculture, and sociology, and religion. Steam trawlers were hopeless in the present circumstances of the Indian fisheries, and when they were introduced, they must be worked by the native fisher-folk themselves; the finest, healthiest, heartiest, and most industrious and strenuous in the world. About Bombay they were hard drinkers, but always overflowing with happiness while at their ceaseless labours. In their long, narrow "dug-outs," with bare room in them for four of these "wave-wandering rowers and riflers of the deep"—[*Fluctivagos nautas scrutatoresque profundi*]—the fire in the prow was always alight; and the curry pot was never off it; and for every long-handled ladle of fish eaten out of it, another of fresh fish, with a pinch of cayenne pepper, was stirred into it, and no daintier dish was ever devised to tempt the appetite, and support the strength of hard-working men. With Dr. Bhau-

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Daji, he (Sir George) had spent days and nights with these stalwart, merry-hearted men in Bombay Harbour, and off Goa; and when at night the moon rose over the sea, they would ever begin some antiphonal chaunt, each boat of the tossing flotilla answering to, and being answered by, every other. It was most romantic, and devotionally soothing, and most delectable. Nearly always the words of the songs were sacred; but once, on a memorable occasion, which must be another story, though the name of almost every Saint in our Christian Calendar was borne to his ears, they were most profanely used, in what proved to be a recitation of "The Temptations of St. Anthony," on the model of the operatic list of Don Juan's misdeeds. Sir Krishna Govinda Gupta said that to improve the condition of these people, or rather to exploit their lives and labours more profitably to the country, we must add English Schools, and Colleges, and Universities, to English Schools and Colleges, and Universities, over all India. And what would be the effect of that, but at the last to ruin the lives, through ruining the livelihood, of this happy industrial Indian community, in exactly the same way as we had already destroyed the labours and the happiness of the indigenous literary and professional classes in India; and to extend the "unrest in India," which now infected only a decimal point of the population, throughout the whole of that vast extended tropical and sub-tropical peninsula, with its teeming population of over 300,000,000, the most patient, the most industrious, the most religious, and the most joyous in the world, if but left restfully and peacefully to work out their own material, and moral, and spiritual prosperity, and happiness, and salvation.

There was no limit to the potential wealth of India in fish—in the pools and ponds, in the rivers, and in the sea. The sacred fish [*cf.* Derceto, and κῆτος, "cetus," and (?) Cette, Cettinge] in the temple tanks of the Concans were packed as close as herrings in a barrel, but all alive, and ceaselessly tumbling over one another, the patriarch of them all being at times distinguished by some ornament fastened to his head or tail; their sacredness being due to the hierophallic Hindu conceptions of their superabounding fecundity; which was indeed the ultimate explanation of the early symbolisation of the Saviour by a fish, although the proximate explanation given at the time when such prehistoric conceptions had been forgotten, was that the Greek word Ἰχθύς was composed of the initial letters of the Greek for:—"Jesus the Christ, God's Son, (our) Saviour." Even in the Victoria Garden which he had laid out in Bombay, at once, as the south-west monsoon burst over them, the deeper gutters became alive with small fish (and frogs), and he used to sweep them up with a winnowing fan, and curry them, whenever required for that purpose, from June to September. All adown the coast of the Concans to Goa, the limit of his voyages, the Hindus eat fish—even the Brahmans, such as Dr. Bhau-Daji—and it was only congers, and other scaleless fish, nor Muslims, nor Hindus [*cf.* Levit. xi. 9–12, and Deut. xiv. 9–10] would eat. But it was equally to the export of cured fish that those who would adventure on the commercial development of the fisheries of India should fixedly look for profitable returns, and in the end the most profitable. It was all nonsense discriminating between cold-water fisheries, as of the North Sea, and the North Atlantic, and warm-water fisheries, as of the Indian Ocean. From the earliest history of the East and of the commerce of the West with the East, India was included among the countries of "the Ichthyophagi,"—Farther India, and India, and Gedrosia [Mekran], and the whole coast of Arabia Felix,—an illuminating fact that should never be forgotten by anyone practically and responsibly interested in this inquiry. Again, the commerce of Europe with the East Indies began in consequence of the pepper, and other spices of India, and the Indian Archipelago, being required for the curing of fish, first of the Mediterranean, and later on of the Atlantic and North Sea; and the whole of our Indian Empire —the most glorious jewel of the Imperial Crown of Great Britain and Ireland—was from the very first latent in these pepper grains, and other spices. It was because the competing Dutch of that day, who connote the competing Germans of this day, raised the price of pepper, by a fraction, against us, that we fitted out "The First Voyage" of our first East India Company, to import pepper, and every other Indian spice, on our own behalf: the "Red Dragon," and her companion ships, starting from the Thames the very week that Akbar, the greatest of "the Great Mogols," lay sick in India, and further sickened by the gloomiest forebodings of evils to come on what was to prove his death-bed. Well, if India only once succeeded in developing her fisheries, she would be found in due time exporting cured fish, as well as pepper and her other spices, into Europe and America; when much of the rivalry between England and Germany in the North Sea, and of England with France, and the United States of America, over the Newfoundland Cod Fishery, would at once begin to lower in temperature,—to something near freezing-point, a consummation devoutly to be hoped for, and obviously latent in the solution of this stirring problem of the development of our Indian fisheries; and from such ports as Kurrachee, and Bombay, and Madras and Singapore. Whenever the solution came, it would largely be due to the good work done by Sir Krishna Govinda Gupta and Dr. Travis Jenkins; and he most cordially seconded the vote of thanks to Dr. Travis Jenkins moved by the Chairman.

The resolution of thanks was then put, and carried unanimously.

Dr. Travis Jenkins, in reply, said he was sorry that he had omitted any reference to Sir Frederick Nicholson, but, as a matter of fact, his paper was entitled "The Fisheries of Bengal," and with the

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limited space at his disposal he purposely omitted referring to other parts of India. He did not see anything of Sir Frederick's work, but he read his reports, and considered they were very excellent ones. In reply to Sir Krishna Gupta, he dated his observations from the time when Sir Krishna started his work. He purposely omitted any reference to Dr. Day, because he had been dealing with recent investigations into fishery questions. In reply to Sir James Bourdillon, a company was started in Calcutta some years ago to exploit the Sunderbans and the Bay, but they went about their work in the wrong way, and the company failed. The same thing happened just before he arrived at Lake Chilka, some Norwegian fishermen having been there and tried to fish without success. His own opinion was that the solution of the difficulty lay in the transport of fresh fish in ice from those localities to Calcutta. If the fish could be bought from the local fishermen cheaper than it could be caught in any other way, what was the use of introducing European methods of fishing? With regard to the question of preserving the fish, he thought, personally, that transport in ice was far better than any other method of preserving. He was sorry the Chairman had taken such pessimistic views of the suggestions made for the development of the fisheries of India, and he trusted he might be pardoned for hoping that they would turn out to be falsified by events.

THE MINING INDUSTRIES OF TURKEY.

Although in the absence of railways it is impossible to take proper advantage of Turkey's mineral wealth except on the sea coast, the mining industry is by no means a negligible factor in the economic life of the country. Salt is a State monopoly, the receipts from the internal trade in the fiscal year 1909–10 aggregating over a million sterling. The export trade amounted to £88,000. While the bulk of the salt produced is consumed at home, some of it is exported to India and Bulgaria. In the Jordan Valley, a French company is beginning to exploit the phosphate of lime deposits, having obtained a concession for that purpose from the Turkish Government, involving a loan to the latter for railway extensions and for the construction of a harbour at Haifa. The minimum annual output is placed at 100,000 tons. The Syrian bitumen beds in the Dead Sea region, at the headwaters of the Jordan, and in the vicinity of Antioch, are not being worked regularly, but these, in the opinion of the American Consul-General at Constantinople, may create a flourishing industry. The mines of an Anglo-French concern operating in the Mersine district in 1910 produced 24,000 tons of iron ore. The same company has opened a zinc mine in the neighbourhood, which in 1910 produced 400 tons of ore, and was expected to yield about 2,000 tons in 1911. Among mines in Turkey which have already reached a certain stage of development, may be mentioned the chrome mines near Alexandretta (output unknown); Mersine, 1,800 tons in 1910; Smyrna, 14,000 tons; and Salonica, 380 tons. The State works certain mines throughout the country, among which are the copper mines at Arghani near Biarbekir. The latter are likely to be leased to a private company for exploitation on a large scale. Coal is already being mined somewhat extensively at Heraclea by French concessionaires, whose contract expires in 1946. The output in 1909 was 654,118 tons, an increase over the previous year of about 100,000 tons. Official permits have been granted for 215 mines, sixty-nine of which are being worked. It may be said, generally, that Turkey is exceedingly rich in minerals, and that its mineral wealth has hardly yet been touched. The mining law of 1906 grants facilities which should act as an incentive to the development of new mining enterprises.

THE ALMOND TRADE IN PROVENCE.

Almonds are grown in many parts of the south of France, but those of Provence are amongst the best, and are considered superior to those of Spain, Turkey and other countries. They are gathered as soon as the outer shell is sufficiently dry to be removed easily. They are then placed on trays, and exposed to dry in the sun for about ten days; they are taken in at night. As soon as the shells appear to be sufficiently dry and the almonds become lighter, they are removed to the warehouse, and packed in boxes rather than in sacks. The shells are bleached by placing the almonds on trays in hermetically-closed rooms and exposing them to the fumes of burning sulphur.

Almonds are usually classed, as those with hard shells (*amandes ordinaires*); those with less hard shells (*amandes demi-fines*), and the soft-shelled varieties (*amandes fines*), the shells of which are easily broken with the fingers.

The shells of the *demi-fine* quality are sometimes softened, by steaming, in order to remove the outer layer of the shell, and then they are sold as the best quality.

Shelled almonds (*amandes cassées*) are chiefly in demand by confectioners (650 to 700 almonds to the kilogram = 290 to 315 to the pound). The principal market for this fruit is the town of Aix, near Marseilles; about 2,000 tons, to the value of eight million francs (£320,000), being exported annually from the south of France, principally to Paris, England, Germany, Austria and Russia.

The soft-skinned kinds are liable to attacks from a small moth, the *Paralipsa gulasis*, which causes considerable damage when the almonds are stored for any length of time. For this reason, the walls and woodwork of the warehouses should be carefully whitewashed, and kept at a low temperature.

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ARTS AND CRAFTS.

Silversmiths' Work.—There is, perhaps, no craft on which the Arts and Crafts movement has had so great and, in the main, so satisfactory an influence as that of silversmithing. Of course, there was a time when every little exhibition of Arts and Crafts was flooded with immature and amateurish work in silver, and there is still a good deal of jewellery and even of larger silverwork to be seen which makes one feel inclined to wish, for the moment at least, that craftwork did not exist, and long for a well, if somewhat mechanically, finished piece of work. Again, as regards jewellery, a conventional craft style has arisen which is quite as marked as, and not much more original than, that of the machine-made work. Not only is it quite possible to go round some exhibitions and tell almost at a glance under what master, or at what school the exhibitors have studied, but it is easy to go further and trace a very strong family likeness in nine-tenths of the objects on view. But, when all this has been admitted, the fact remains that at the present time there are quite a number of silversmiths who are also artists — perhaps it would be more accurate to say artists who are also craftsmen, for in England there is a tendency to begin from the side of art, just as in France the starting point is generally technique. Since silverwork and jewellery are, for those who can afford them, the most fitting kind of presents, it is by no means surprising that some at least of the artistic silversmiths make an effort to have a good supply of work at Christmas time, and to show it either in their own studios or in one of the smaller galleries.

Messrs. Ramsden and Carr and Mr. Alexander Fisher.—There have been two noteworthy shows of metalwork this season—that of Messrs. Ramsden and Carr, at St. Dunstan's Studio, Seymour Place, South Kensington, S.W., and that of Mr. Alexander Fisher, at the Leicester Galleries. Messrs. Ramsden and Carr's show was somewhat different from their usual winter exhibitions, as much of their larger work this year has been commissioned for the colonies and other places abroad, and they found themselves, therefore, more dependent than usual on smaller things. In one way this was no drawback, for it left their visitors more leisure to see how successful they are in making ordinary objects of common use, such as toast-racks, table-napkin rings, silver cups, boxes, forks and spoons, and the like—real works of art. However, the interest of large work was not lacking, as there was a tall two-handled cup and cover ornamented with bas-reliefs to be presented to a mining engineer, and also several large caskets and a very elaborate tobacco-box with decorations illustrating Chaucer's "Man of Law's Tale," whilst photographs of other works were on view. The reproduction of the brass lectern, formed by a bold and severe heraldic eagle, was perhaps the most noteworthy; but that of the large boat-shaped centrepiece and candelabra, made for the Jockey Club of Mexico, was full of vigour and by no means wanting in interest. The impressions of the episcopal seals of the Bishops of Winchester and Oxford were up to their makers' usual high standard in this kind of work. There was a much more attractive show of jewellery than usual: the small chains were dainty and ingenious in the extreme, and several of the pendants and other more important pieces were really beautiful.

Messrs. Ramsden and Carr's individuality is always very marked, but, like most of the best craftsmen, they are the product of the past. Their work is modern in the best sense of the term, but it is most happy, mostly truly and evidently their own, and generally most satisfactory, when it is distinctly Gothic in feeling. Mr. Fisher, on the other hand, is a modern of moderns. The expression *art nouveau* has become so much a term of opprobrium that it seems almost unkind to apply it to really good work like that shown at the Leicester Galleries, and yet it is the new art which has influenced Mr. Fisher far more profoundly than the ancient styles. We find here and there in his work, lines and curves which were considered the height of modernity some years ago; but the artist is no follower of any set style, not even the most modern, and his work as shown in Leicester Square reveals a quite unusual combination of individuality and versatility. Perhaps the most interesting piece of work is the cup, partly of silver, with a broad band of decoration in *plique à jour* enamel round the top, a carved ivory bowl and a stem built up of carefully chosen bits of *lapis lazuli* arranged facet-wise. The quality of the enamel is unusual for work of this kind, as it is semi-opaque instead of brilliantly translucent. This detracts somewhat from the beauty of the enamel itself, but is far more in harmony with the ivory bowl below it than the brighter material would have been. Of the enamel panels exhibited, the most striking is the one entitled "Until the Day Break," in which the flaming red of the angel's wings is a truly gorgeous piece of colour. The colour-scheme of the enamel decoration of the small electric bell, on the other hand, is quite beautifully delicate and tender. Amongst the larger pieces of work on view, the massive silver wine-flagon is perhaps the most satisfactory, as well as the most attractive, but the steel casket and the bronze mirror are also well worthy of notice. The jewellery is for the most part rather large and massive. This is no drawback in the case of the two morses, one of which, representing the Adoration of the Magi, is a very happy piece of work. The silver setting, again, of one of the enamel clasps, simple as it is, demonstrates that the man who made it knew what he wanted to do and did it. But, on the whole, the jewellery was the least satisfactory part of the exhibition, not so much because the things themselves were not beautiful as because they were less eminently fit for their purpose than they might have been.

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Home Arts and Industries.—The winter exhibition of the Home Arts and Industries Association is always a less serious affair than their summer show, but the association is careful not to let it degenerate into a glorified bazaar. And this year one felt no desire to judge it from a lower standpoint than usual. There was, indeed, one stall which might with advantage have been omitted, but for the most part the exhibition justified itself as a legitimate collection of artistic craftwork of varying degrees of excellence. The show of metalwork was rather smaller than it has sometimes been, but the simple hammered work from Keswick was satisfactory, even when such important work as a silver altar cross was attempted. A good deal of lace was shown; Honiton, guipure and filet were all well represented, but there was little or no Buckingham lace. The Kingston-Bagpuize metal lace was for the first time applied to velvet and other materials to ornament collars, belts, and the like, and showed to much better advantage than usual. All lace is difficult to display successfully on a stall, but gold and silver lace takes even more careful arrangement than the ordinary white and cream varieties. From Langdale came some beautiful Greek lace and drawn thread work—the prettiest perhaps, that in which the stitchery was in white on a sort of unbleached coloured ground. The embroidery and appliqué work sent by the Wilton Industries was, as usual, bold and attractive—the very kind of thing which can be best executed by a village class if, and it is a very big if, the classholder has sufficient knowledge, ability and initiative to carry it through. An attractive little group of Mrs. Watts' pottery was on view, and some dainty inlaid wooden boxes and the like were shown by the Hanwell class. The best leatherwork was from Chiswick, and included bookbinding and lacquering. The hearthrugs, etc., from Birmingham, made by feeble-minded girls, were, as a rule, very warm and pleasing in colour, and much of the weaving, too, was remarkably satisfactory in this respect, whilst the simple pattern weaving shown was, as on previous occasions, all that could be desired. The work attempted, was, as a whole, unpretentious enough, and it was probably for this very reason that so much of it was really good of its kind. The increasing popularity of home art work is not always a good thing, but there is a great deal of hope for the future in an exhibition like this.

EMPIRE NOTES.

The New Commonwealth Office in London.—It is about four years ago since negotiations were first opened with the London County Council to acquire a suitable site for the Australian Commonwealth offices in London. Australian public opinion has held it essential that not only a good but a freehold site should be selected. It was thought, at one time, that the buildings facing Trafalgar Square, where the Strand and Northumberland Avenue converge, might be chosen, but this proposal was subsequently abandoned. The Strand-Aldwych site has now been secured by the Australian Commonwealth from the London County Council. This, without doubt, is one of the finest sites for the purpose in London. The scheme of building will involve an expenditure of over £200,000, and, together with the purchase price, will reach nearly £600,000. The interest on a considerable part of this amount will doubtless be provided by sub-letting offices, on the various floors, to the different State Governments, and possibly to some private firms. It has been suggested that if the whole of the island site in Aldwych could be acquired, Canada, New Zealand, and South Africa might erect buildings upon it, and so an Imperial centre be secured, which would be architecturally and commercially an adornment and an advantage to London, and to the Government Agencies of our Dominions.

Australian Emigration and Immigration.—The Department for External Affairs has recently issued a report, giving interesting figures as to immigration and emigration in connection with the Australian Commonwealth for last year. The statistics of emigration show that during the year the following coloured people left Australia:—Chinese, 2,310; Papuans, 548; Japanese, 462; Malays, 261; Hindoos and Cingalese, 229; Filippinos, 67; Pacific Islanders, 54; Afghans, 25; Syrians, 27; Javanese, 19; and others, 80. The total of immigrants in the twelve months, to whom the dictation test was not applied, was over 90,000, made up of:—Europeans: British, 81,457; Austrians, 816; Belgians, 50; Danes, 269; Dutch, 175; Frenchmen, 116; Germans, 2,449; Greeks, 380; Italians, 383; Poles, 11; Portuguese, 3; Russians, 35; Scandinavians, 1,210; Spaniards, 49; Swiss, 109; Turks, 10; others not specified, 25; Americans (including 27 negroes and West Indians), 786; Asiatics, 3,083; Maoris, 62; and other coloured races 821. It was not intended that Asiatics and other coloured races (excluding Maoris), which made up a total of 3,931, should have unrestricted entry into the Commonwealth. No fewer than 1,955, however, most of whom were Chinese, were able to show to the satisfaction of the officers that they had been formerly domiciled in the Commonwealth. Sixty-nine were deserters, whose traces were soon lost in the population of the Commonwealth, 627 were admitted temporarily under certificates of exemption, nine were allowed to land accredited as Government representatives on special missions, 1,525 were pearlers, 39 (mostly Syrians) came in under special Ministerial authority, 25 had passports, and 36 gained admission in connection with police-court proceedings. Of the total, 3,931, it is likely that about half would, after specific terms, leave the Commonwealth again. About 2,000 would be absorbed in the Commonwealth population, but nearly all of these would be coloured persons who were formerly domiciled in Australia. Only forty-two persons were refused admission to the

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Commonwealth. The total was made up of thirty-two Chinese, five Britishers, two Japanese, one Hindoo, one Malay, and one Syrian. Two Britishers were rejected, on the ground that they were likely to become a charge upon the public, or public or charitable institutions. One of the others was considered to be insane, and the remaining two were adjudged to be disqualified, under the section of the Act dealing with persons suffering from an infectious or contagious disease of a loathsome or dangerous character. In view of the often alleged difficulties placed in the way of intending emigrants to Australia, it is certainly interesting to know that out of over 90,000 persons, only forty-two were refused admission to the Commonwealth last year, and of these only five were Britishers.

Wireless Telegraphy in Australia.—Protracted disputes have taken place in Australia between the various parties concerned in wireless telegraph systems. To these the Postmaster-General referred in the Federal House of Representatives on December 8th, and at the same time announced the Government's intention of erecting wireless stations round Australia on a system invented by the Government's wireless expert. In regard to these disputes an interesting and perhaps unique incident occurred in the great Australian Bight, when three steamers came into wireless connection. One steamer, to which a message was addressed, could not receive and reply on account of its being bound to adhere to one code. The message, however, was taken up by the third steamer, which was independent. It was eventually decided that the steamer called upon could receive a message but could not reply to it. It would be interesting to know, in the case of distress signals issued in diverse codes, whether steamers having different systems can receive messages and render aid.

New Zealand and Prohibition.—The question of the prohibition of the sale of spirituous and other liquors in New Zealand has for some time been exciting much public attention, and recently a referendum was taken on the question. The reports received as to the result of the referendum show that 255,864 votes were given in favour of the measure and 202,608 against it. The votes in favour of national prohibition thus amount to 53·93 per cent. of the total votes polled. As the proportion required to carry the proposal through is 60 per cent. the matter has fallen through despite the large majority in its favour. In many districts in New Zealand local option obtains, and, where this is so, the local vote has been three-fifths of the whole in favour.

British Columbia Fruit Lands.—Considerable interest is being evinced in the Watshan Valley orchards of British Columbia. The Valley is situated on Arrow Lake, and is reached by the Canadian Pacific Railway train to Arrowhead, and from thence by C.P.R. steamer to Needles. Some remarkable land-clearing machinery has been introduced into the district, and upwards of two acres a day can be cleared by one gang of men. Watshan Valley is being developed on entirely new lines, as settlers, when they arrive, find their selections already cleared and planted, and are thus spared a long and arduous struggle with nature before they start to make a living. According to reports, Needles is likely in the near future to develop into a large apple-growing exporting district. Experts all over Canada are watching with interest this method of clearing and settlement, and, if it proves a success, other districts will instal similar machinery for removing trees, and so greatly expedite the transition of forests into orchards and gardens suitable for immediate settlement. Blocks of land are now being offered, as an investment, to residents in the United Kingdom, and an effort is being made by the vendors to secure a Government report on each separate holding. By this means, an investor, without seeing his property, would be assured that his land is all that is claimed for it. For a small annual payment the vendors undertake to supervise and cultivate the holding, until the trees are in bearing. Until this year, no British Columbian apples have been offered for sale in England, but a few days ago a sample shipment of 600 cases was received at Covent Garden Market. The shipment was in splendid condition, and good prices were obtained. The English market is rarely glutted with a good class of apple, and there appears to be an excellent opening for British Columbian fruit.

A Floating Dock for Vancouver.—For some time past, prominent citizens of Vancouver have been promoting a dry-dock scheme for Vancouver Harbour. It is proposed to construct a dock of such dimensions that any large steamship likely to enter the port for many years to come may be able to be accommodated. It has been realised that the tonnage of vessels plying on the Pacific has been increasing so rapidly that if Vancouver is to move with the times some such scheme must be adopted, and that speedily. The proposed dock is to be 600 feet long, 55 feet deep, and 80 feet broad, and is to have a lifting capacity of 15,000 tons dead weight. Such a dock, it is considered, will be sufficiently large for the purpose, but the promoters, being aware that at the present time the bulk of the shipping entering their port is of the medium type, have arranged that the dock should be designed in two sections, which gives them practically a double plant for use, in the case of ordinary shipping. When necessary, the two sections can be joined together and thus make one huge dock. Capital for the scheme has been subscribed both in London and Paris, and joint boards have been established in those cities.

The Development of the Windward Islands.—The Governor of the Windward Islands was recently in this country, and, whilst here, made some interesting statements with regard to the developments of these islands. Before resuming his residence at Grenada he is to make a tour of the islands of St.

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Vincent and St. Lucia. The islands are gradually recovering from the bad times they have been undergoing, and are now in a more prosperous condition. The cacao industry is flourishing, and St. Vincent cotton has fetched the highest prices in the world. A scheme of peasant proprietary has been inaugurated to assist small growers in the islands of Grenada. The scheme has proved a satisfactory one, and of great value to the settlers in the neighbouring islands. With a view to attracting visitors to the islands, which offer a delightful winter resort, arrangements are being made to start a large hotel at Grenada. The greater part of the trade of the islands is with the United Kingdom, but in Grenada, which has no sugar export, there is considerable commerce with the United States.

Vanilla-growing in the Seychelles.—The Administrator of the Seychelles has issued an interesting report with regard to vanilla crops harvested during the last year. The report states that vanilla plants are being gradually restricted to the higher zones of the mountains, owing to the successive dry seasons. With the legislation in France and the United States restricting artificial substitutes of this product, there has been a growing reluctance on the part of the manufacturers to use them, and this appears to be a very good reason why vanilla cultivation should be brought into greater prominence and become eventually one of the principal industries of the colony. It is true that the yield fluctuates considerably, but even the famine harvest of 1909 realised over 200,000 rupees, and was third in value in the exports for that year.

GENERAL NOTES.

International Society for the Promotion of Commercial Education.—The sixth international course of lectures on "Commercial Expansion" will be given at the Commercial High School, Antwerp, from July 22nd to August 10th, 1912. It will be organised, like previous courses, by the International Society for the Promotion of Commercial Education, with the aid of a patronage committee composed of a certain number of persons well known in the industrial and commercial circles of Belgium, and presided over by several Ministers. An executive committee, having for its president M. E. Dubois, Director of the Commercial High School of Antwerp, will undertake all details of organisation. In accordance with the main object aimed at by the various international courses of lectures on Commercial Expansion which have been given, since 1907, in Lausanne, Mannheim, Havre, Vienna, and London, it is proposed in the sixth course to study as fully as possible the economic state of Belgium, its industrial and commercial development, its political institutions, its artistic treasures, the port of Antwerp and its installations, and the colony of the Belgian Congo. The provisional programme puts forward the following sections:—(1) General survey of the geography of Belgium (one lecture); (2) Belgian agriculture (one lecture); (3) industrial Belgium (8 lectures); (4) Antwerp, port and commercial centre (five lectures); (5) other ports and means of communication (two lectures); (6) the foreign trade of Belgium (three lectures); (7) the money system, credit, and banks (two lectures); (8) political and administrative organisation (two lectures); (9) the Belgian Congo (four lectures); (10) Picturesque and historical Belgium, ancient and modern paintings; sculpture (6 lectures). For all information, apply to M. E. Dubois, Directeur de l'Institut supérieur de commerce d'Anvers; 41, rue des Peintres, Anvers, Belgium.

International Congress of Americanists.—The International Congress of Americanists have accepted the invitation, issued by the Royal Anthropological Institute, to hold their eighteenth session in London in 1912. This congress, which meets every two years, is devoted to the historical and scientific study of the two Americas and their inhabitants, and the papers read and the questions discussed during the session relate to the following subjects:—(A) Native American races, their origin, their geographical distribution, their history, their physical characteristics, languages, civilisation, mythology, religion, habits and customs; (B) Native monuments and the archæology of the Americas; (C) History of the discovery and European occupation of the New World. The congress has already met three times in France (Nancy and Paris), twice in Germany (Berlin and Stuttgart), once in Austria (Vienna), twice in Spain (Madrid and Huelva), once in Italy (Turin), once in Belgium (Brussels), once in Luxemburg, once in Denmark (Copenhagen), once in Sweden (Stockholm), and three times in America (Mexico, New York, and Quebec). In the list of countries which have extended hospitality to the congress, the name of Great Britain has hitherto been absent, although this country has taken so large a share in the exploration and colonisation of America, and is the only European Power still holding large possessions in that continent. Arrangements are being made for the session of the congress to be held at the University of London, during the week commencing May 27th, 1912.

Imports of Cheese to Belgium.—The *Bulletin* of the French Chamber of Commerce of Charleroi states that the total quantity of cheese imported by Belgium during 1910 amounted to 11,852,927 kilograms (equal to 233,331 cwts.). Of this the greater part was imported from Holland, viz., 10,123,806 kilograms; 802,104 kilograms from France, 625,671 kilograms from Switzerland, 209,153 kilograms from England, 58,591 kilograms from Germany, whilst the remaining 33,602 kilograms were supplied by other countries

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Journal of the Royal Society of Arts.

No. 3,084. VOL. LX.

FRIDAY, DECEMBER 29, 1911.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 3rd, 5 p.m. (Juvenile Lecture.) CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." (Lecture I.)

The lecture will be illustrated by numerous experiments.

Most of the tickets have now been issued, but some still remain, which will be supplied to Members who apply for them at once.

Further particulars of the Society's meetings will be found at the end of this number.

EXAMINATIONS, 1912.

The Examinations will be held from March 25th to 29th inclusive.

The last day for receiving applications will be February 20th.

The following are the subjects:—Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Business Training, and Modern Languages.

The Examinations will be held at any place in the United Kingdom where an Examination Committee is willing to undertake the necessary arrangements. Applications for new centres should be submitted for approval at once.

The Examination Programme for 1912, containing the regulations for the formation of new centres, syllabuses of all subjects, and the papers set in 1911, may be obtained from the Secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C. (price 3*d.*, post-free 4½*d.*).

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE CARBONISATION OF COAL.

By VIVIAN B. LEWES,

Professor of Chemistry, Royal Naval College, Greenwich.

Lecture II.—Delivered December 4th, 1911.

THE METHODS EMPLOYED IN THE DESTRUCTIVE DISTILLATION OF COAL.

In the destructive distillation of coal both for gas and coke production the coals dealt with are bituminous in their character, and are comprised in classes 2, 3, and 4 of Gruner's classification—that is, they all contain enough resin constituents to yield a gas of good illuminating value and a high percentage of hard coke, but the quality and quantity of both gas and coke will depend upon the conditions under which the distillation is carried out, and these have been gradually evolved during a century of practical experience to the point which gives the results attainable at the present time. Before discussing the process of carbonisation from the scientific side of the question, it will be well to review the changes which have taken place in the methods employed; as, although they have been based largely on economic considerations, they show also the conditions which influence the yield, composition and characteristics of the various products.

When Murdoch first made coal gas at Redruth, the retort which he employed was simply a cylindrical iron pot, set in the same way that a scullery copper is over an open fire. It held a

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charge of 15 lbs. of coal, was closed at the top by an iron lid, and the gas was led off 3 ins. or 4 ins. below the lid by a horizontal iron pipe. The trouble, however, of removing the coke after the carbonisation of the charge was so manifest and serious a drawback that as early as 1802 he had adopted a horizontal cylindrical vessel, from which the charge could be more easily raked out, whilst the flue was so constructed that the flame surrounded the retort and then made its escape direct into the chimney. He seems to have tried several settings of this character with retorts varying in size from 1 ft. to 20 ins. in diameter, and from 3 ft. to 7 ft. in length.

At this period also he seems to have tried a cylindrical retort placed at an angle of about 45°, with a mouthpiece at each end to aid in charging and discharging. None of these earlier forms of retort were of any great size, the usual charge he employed being about 15 lbs.; but soon after he reverted to the pot form, and, in order to facilitate the discharging of the coal, fitted into it an iron cage, which was put in before the coal charge, and which could be lifted out bodily by means of a small crane. In this he carbonised 15 cwt. of coal at a time, and in this experiment came upon a trouble which is common to every process of carbonisation in bulk, and that is that the process of carbonisation proceeds rapidly at first, producing a layer of coke next to the heated surface; and this, being a bad conductor of heat, retards the process of carbonisation owing to the slowness with which the heat is transmitted to the inner portion of the charge, whilst the gas evolved in the interior portion of the charge, having to pass through the heated coke, loses a large proportion of its illuminating power in consequence of the breaking down of the rich hydrocarbons with liberation of oxygen.

Before 1810 Murdoch had also discovered that in order to get the best gas yield a high temperature was necessary, and that if carbonised at too low a temperature the volume of tar produced was greatly increased, and the yield of gas reduced in a corresponding ratio. He also made a certain amount of progress in the setting of the retorts in the furnace by making flues around the horizontal retorts, which would ensure as much as possible of the heat being utilised.

At this period the evils arising from submitting the gas to too long a travel through the incandescent coke seem to have been generally realised by other observers, and attempts began to be made to carbonise the coal in thin layers, so that the gas should escape more freely and would not have to pass over any very great surface of heated carbonised material. A retort was patented by Clegg in 1815, which he termed a rotary retort, and which consisted of shallow boxes attached to radial arms rotating on a central shaft; the coal gas was charged in at the cool side of the shallow circular retort into the trays, and in this place also the tray of coke could be removed. Carbonisation took place on the heated side of the retort, into which the radial arms carried the tray containing the new charge. Although several installations were erected, as might be expected, they proved a failure, a fate which also befell his web retort, in which an endless chain carried the coal to be carbonised in a thin layer through the carbonisation chamber.

The advantages of a thin stratum of coal, however, having been fully recognised, Malam introduced wide oval retorts set in a horizontal position, the bottom only of which was charged with the coal, and he further made an advance in the setting by placing five and six retorts in a bench heated by three fires.

By 1841 the form of retort used seems to have settled down to an oval D-shape or circular retort, five of which were placed horizontally in the same bed or setting, and these retorts, being rapidly deteriorated by direct contact with the fire, were protected by fireclay shields or tiles.

In none of these early retorts, however, could any temperature beyond 800° C. be employed, as otherwise the exterior became so acted upon that they had a life of only a few months, whilst with the greatest care their life was seldom more than eight or nine months. Even when working at lower temperatures than those usually employed, it is found that great trouble is caused by what is known as the "growing" of iron, which takes place unless the greatest possible care is taken in the selection of the metal. This phenomenon is caused by the hydrocarbon gases permeating the metal and becoming decomposed there, so leaving a deposit of carbon, which gradually forms a spongy mass, and it is not an unusual thing for a 10 ft. retort to increase two or three inches in length after a few months' working.

This trouble with the metal retorts led to attempts being made to introduce fireclay retorts, but these met with such opposition that it was not until nearly the middle of the century that they became generally adopted. Before fireclay retorts became general, however, brick ovens were used at many places; the early ones were square and capable of containing about

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4 cwt. to 5 cwt. of coal per charge, but later were altered to a flattened D-shape and increased in size, so as to be capable of receiving a charge of 10 cwt. to 12 cwt. of coal. In these carbonisation seems to have been very rapid, as five hours is given as the time taken to carbonise the charge, but the consumption of fuel was excessive, sometimes rising to 70 per cent. of the coke produced. This, however, was probably largely due to faulty construction of bad settings and furnace and general flue arrangements. Their life, however, was four or five years, and they produced coke of a very good quality.

In the early fifties fireclay retorts almost entirely displaced these ovens, and have ever since been adopted, their section being made much the same as with the old iron retorts.

As can easily be imagined, the fifty years that saw the inception of the gas industry also saw great advances in the retort settings, and these resulted in considerable fuel economy, so that by the early sixties the fuel consumption had settled down to about 20 per cent. of the coke produced. Up to this time most of the retorts had been what is termed "single-ended"—that is, closed at one end—and had only one mouthpiece; but in the larger works double-ended retorts, with a mouthpiece at each extremity, soon began to displace these.

The advances which had been taking place both in the material of the retorts and in the settings had led to a general increase in the temperature of carbonisation employed, but even in the days of the iron retorts it was found that considerable trouble arose from a crust of dense carbon deposited on the inner surface of the crown of the retort, due to the effect of heat upon the escaping hydrocarbons, and when with the introduction of fireclay retorts the temperatures were raised, this became a very serious trouble, as it led to the retort having to be scurfed at frequent intervals, and if this was done mechanically, as it generally was, great damage to the retort resulted. A slight improvement took place with the discovery that the deposit could easily be burnt off by causing a flow of air over the surface of the retort when heated and empty, which burnt off the carbon, and that a mixed steam and air blast could be used with even greater advantage for this purpose. The trouble, however, was at one time so great that it appeared as if the limit of temperature had been reached, but the discovery of the fact that pressure had an enormous influence in causing this deposit led to the introduction of the exhauster to suck the gas away from the retort, and this giving the possibility of working with little or no pressure in the retort, led to a great improvement in the amount of deposit formed, and also in the quality and quantity of the gas produced.

About 1885 Coze introduced the idea of placing the retort just at the angle of slip of the coal, so as to utilise gravity to aid in the charging and discharging, the former being done from a hopper through the mouthpiece at the upper end of the retort, whilst after the charge had been carbonised the removal of a stop and the "tickling" of the charge caused it to slide out, and this idea being gradually adopted the inclined retort has played a very important part in gas manufacture during the past twenty years, and by the application of gas-firing, and regenerative settings, very high efficiency has been obtained from them.

The idea of regeneration, which was adopted for all forms of settings, enabled heats to be attained which before had not been possible, and this, coupled with gaseous firing, gave a control of temperature the importance of which cannot be over-rated.

Since 1893, when the advent of the incandescent mantle as a practical method of developing light began to do away with the necessity for gas of high illuminating value, so general became the adoption of the mantle that in 1900 applications began to be made in Parliament in various gas bills to reduce the standard of light for those companies whose previous average had been about sixteen candles, it being felt that a fourteen-candle gas was better fitted for yielding light with the incandescent mantle, power in the gas engine, and for heating in gas stoves, than higher qualities; and it also gave the possibility of economies in manufacture, which it was hoped might lead to lowering of the price of gas to a point at which it would better compete with fuel gas for power purposes.

During the last ten years there has been an amount of activity in attempts to alter the process of gas manufacture which has exceeded any that has taken place since the first few years of its inception, and this new era may be considered to have started with the inauguration of the vertical retort, in which, by utilising a large oval fireclay retort set on end, and with a slight taper from bottom to top, much larger charges could be used than had been possible with the horizontal or inclined retorts, and in which also gravity was utilised to the full for charging and discharging.

The vertical retort dates back to 1828, when

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it was first introduced by John Brunton, who, finding that the gas could not escape freely from the lowest portions of the charge, and so created considerable pressure, put a perforated pipe in the centre of the charge to afford an easy way of escape. Nothing more was heard of the process, so I presume it failed, but at later dates attempts of the same kind were made by Lowe and Kirkham, and also by Scott.

After these early experiments nothing seems to have been done for sixty years, until the summer of 1903, when Settle and Padfield put up a vertical retort at Exeter, and Dr. Bueb started experimenting on the subject in Germany.

In Bueb's patent, which is dated July 7th, 1902, he sets forth the trouble in the early forms of retort from the gas in the lower part of the charge having to traverse the column of incandescent coke above it, and proposes to overcome this by heating the retort only on three sides, and having a series of nostrils on the cool side through which the gas could escape from all parts of the charge. The fallacy of such an arrangement must soon have become manifest, as by July, 1904, an experimental setting of ordinary verticals was at work at Mariendorff. In July, 1904, also, Duckham and Woodall brought out their first patent, and with the Settle and Padfield process still being experimented with, the new era of vertical carbonisation was well started.

Vertical retorts during the last few years have met with great success on the Continent, and their use has spread with the greatest rapidity.

In England it has been felt that, good as are the results obtained with the vertical retort working intermittently—*i.e.*, by putting in a full charge of coal, carbonising and drawing, and then recharging in the same way as with the old form of retorts—great improvements could be effected by making the process continuous, as was first attempted by Settle, so approaching more nearly to uniform conditions of carbonisation. Vertical retorts on this principle have been devised by Messrs. Duckham and Woodall, and by Messrs. Glover and West, and they certainly show results which will lead to continuous carbonisation being one of the most important factors in the future of gas manufacture.

The economies to be derived from carbonisation in bulk have, on the Continent, led to still further advances in the size of the charge; and little more than three years ago chamber carbonisation was introduced at Munich, in which charges of three to eight tons of coal can be dealt with at a time, and this method also has met with a large amount of success, a number of installations having been erected on the principles laid down by Ries, Koppers, and others.

Many observers felt that the old horizontal retort could be made to yield better results than had hitherto been obtained, and Mr. C. Carpenter, at the South Metropolitan Gas Company's works, found that great advantages may be obtained by packing the old horizontal retorts full of coal, as had been suggested by Kunath in 1885, instead of only partly filling them. This does away with the large space that had always been left above the charge of carbonising coal, and so eliminates to a great extent the baking of the gases and contact with the heated crown of the retort, thus giving a distinct advance in make and quality, not only in the gas but in the tar.

At Norwich, Mr. Glover has installed a form of retort which is a compromise between chamber carbonisation and a full charge in the horizontal retort, and which has been giving a marked advance in the products obtained by the carbonisation.

As before pointed out, whilst these changes in form have been taking place, improvements in the settings, gas fuel and regenerative firing, have made such strides, that the temperatures employed are limited only by the nature of the refractory material used, and the result of these higher temperatures with light charges is to increase largely the volume of the gas obtainable per ton of coal, but at the same time its illuminating value is reduced and the tar is deteriorated, and it also gives rise to stoppage of ascension pipes and an increase in naphthalene troubles in the service.

When iron retorts were used the heats that could be employed were limited by the softening point of the iron, and rarely rose above 800° C., and although only 9,000 cubic feet of gas were made per ton of coal, the gas was rich in heating and lighting value, and the tar excellent in quality. The advent of the fireclay retort, as has been seen, enabled temperatures to be increased, and 10,000 cubic feet of gas was the general yield. With the introduction of regenerative firing the volume of gas obtained rose to 11,000 cubic feet, whilst the more modern developments approach a yield of 13,000 cubic feet.

In all these changes the gas-manager has been actuated by the desire to get the greatest volume of gas possible per ton of coal, and at the same time to do it with the greatest economy, and but

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little attention has been paid to the quality of the tar and coke, which have been looked upon as by-products. In point of fact, the tar, when heats were pressed to their highest in lightly-charged horizontal retorts, became so poor and choked with naphthalene and free carbon as to be almost valueless.

The introduction of large masses of coal in carbonisation, for reasons which will be discussed fully later, has led to distinct improvements in this respect, and although there is no modern tar which approaches in value the product of the old iron retort, the improvement in many places of late has been most marked.

The idea of converting coal into coke first arose from the desire to supplement charcoal for metallurgical work by some other form of fuel which would have much the same characteristics, this being necessitated by the fact that the timber on which the charcoal supply was dependent was rapidly becoming depleted. The characteristics desired were—local intensity on combustion, strength of structure, smokeless burning and infusibility, together with as small a proportion of sulphur as possible, and the only raw coal which could have been employed to fulfil these requirements at all was anthracite, which has always been comparatively high in price and somewhat difficult to deal with in practice.

The bituminous coals, which were the ones generally available, could not, for instance, have been used in the blast furnace, on account of their swelling, softening, and forming arches, which would have interfered with the descent of the charge in the furnace and passage of the hot gases, whilst the intensity of the heat would have been low, owing to the amount withdrawn by the gases and vapours, and rendered latent in distilling off these volatile products, and also because of the oxygen present in the coal. When, however, bituminous coal is converted into coke the residue is infusible, its friability is decreased, and with the concentration of the carbon—although the total increase in calorific value is small, no heat being withdrawn by the distillation—the local temperature is very largely augmented.

With the increase in coal mining which took place in the first half of the last century, another important reason for the coking of coal presented itself. In all collieries raising bituminous coal the percentage of slack and small was high, and where any of the coal is of younger formation, the smalls will sometimes amount to 40 or 50 per cent., and as before the introduction of automatic stoking machinery the demand for this was very limited, all the screenings and smalls of a colliery had to be sold at a very low and unremunerative rate. With a comparatively small amount of labour, however, these screenings could be converted, in the old coke meilers and beehive ovens, into larger masses of hard coke exactly suited for metallurgical and furnace work.

Another reason, which was not at first recognised but has now assumed great importance, is that the sulphur present as pyrites and other sulphur compounds in all coal can be substantially reduced at a very low cost in properly made coke; this being due to the fact that the larger pieces of pyrites having been hand-picked, a considerable proportion of the impurities, including residual pyrites, can be got rid of by crushing the coal and washing it, when, being heavier than coal, it can to a great extent be separated by gravity in the trough and jigger washers. On coking the washed coal the heat expels a considerable proportion of the remaining sulphur which comes off with the gases as sulphuretted hydrogen, carbon disulphide, and other organic compounds of sulphur, whilst quenching the red-hot coke on its removal from the oven eliminates another small percentage, so that a very substantial decrease in this deleterious constituent of coke for metallurgical work can be obtained.

With the introduction and general adoption of coal gas in the early years of the last century, coke was yielded as a by-product of the destructive distillation, but the gas manufacturers, looking upon it as a by-product, have from that day down to the past few years paid little or no attention to modifying the process of gas manufacture with a view to improving the quality of the coke produced, with the result that gas coke has always been looked upon as an inferior product, and the market which it commanded has been of a limited character. It has never achieved much success as a domestic fuel, and its chief output has been due to its use by small manufacturers, for horticultural work, heat production in the gasworks, and the generation of water gas and producer gas.

Coke may be divided into two main classes:—

1. Metallurgical and furnace coke, made by processes in which everything has been done to obtain the largest yield of coke having definite characteristics, and in which the by-products, gas and tar, are either disregarded or considered of secondary importance.

2. Gas coke, made by processes designed to

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give the largest yield of gas, in which as much of the carbon as possible shall be in gaseous combination, the coke residue and tar being looked upon as of secondary importance.

In making the first class of cokes the factors which are desired in the process are—using coal only rich enough in resinic volatile matter to give the necessary coking or binding properties to the mass, to crush the coal to uniform size, to use large charges, densely packed, and to carbonise for long periods, raising the outer crust of coke first formed to as high a temperature as possible, so that, as the heat penetrates into the mass, the hydrocarbon gases and tar vapours being evolved shall be decomposed by contact in their passage through the envelope of red-hot carbon, depositing as much of the gasified carbon as possible, so that it is only the more stable hydrocarbon gases and most volatile vapours that escape; the ideal carbonisation from the coke-maker's point of view being the retention of the whole of the carbon in the mass.

In gas manufacture, on the other hand, in the ordinary process employed at over 90 per cent. of gasworks, the coal used is as rich in resinic volatile matter as can be obtained without going to undue expense. Small charges are used in order to reduce the time needed for carbonisation, and also to reduce the contact with too large a surface of hot coke, and the temperature employed is limited only by its effect on the life of the refractory material used, and to avoid stopped ascension pipes and other troubles inseparable from overheating, and to continue the carbonisation only long enough to drive out all volatile matter. Under these conditions the gas yield is increased to the highest limits compatible with leaving in it enough hydrocarbon gases to comply with parliamentary requirements as to illuminating and heating value, and the coke is looked upon as a by-product that will pay a share of the coal bill; the ideal condition of carbonisation from the gas-manager's point of view being the conversion of the whole of the coal into gas, an ideal within measurable distance when using high heats obtained by employing 15 per cent. of the coke for heating the settings and converting the remainder into water gas.

It is clear that two ideals so fundamentally opposed to each other must be hard to reconcile, and in its broadest sense the question is simply—Given a definite weight of coal, how can it best be used to avoid waste and secure the highest monetary return, whilst at the same time satisfying the requirements of the various classes of consumers? Simple as the query seems at first sight, it is one that demands a consideration of the whole of the procedure in the various methods of carbonisation practised.

The classes of coals used for making metallurgical and furnace coke are those which on heating fuse to a sufficient extent to convert the mass of powdered coal into a pasty mass, from which on slow heating the volatile matters distil out, leaving a fixed carbonaceous residue which binds the free carbon into a hard mass.

It seems probable that the nature of the luting material between the particles when a coking coal is carbonised, is entirely dependent upon the temperature attained and the length of time for which it acts. It is, in fact, the residuum of the least volatile portion of the coal, and if the action has not been carried on for a sufficient length of time at a high enough temperature, hydrogen and oxygen will be found in it, and the last traces of these are very difficult to eliminate.

It is only coal that contains a certain quantity of bituminous matter that will yield a well-caked coke. If we take coals containing a very high percentage of carbon, like anthracite or steam coal, they will not coke; and in the same way tertiary coals, like lignite, containing a large proportion of humus, will not coke, so that the largest proportion of coking coals come in the true bituminous class. Thus, the coals used for gas making are nearly all coking coals, with the exception of cannel, which is now very little employed, and in which the high ash content is a drawback.

The coking coals themselves, however, may be divided into two classes—(1) the most bituminous, which give the largest percentage of gas, and are so chosen for gas making, and (2) the less bituminous, which are the best for cokeworks; the reason being that high gas yield means a high proportion of carbon lost as hydrocarbon gases, whilst this loss is less as the volatile matter decreases, enough, however, remaining to yield the pitch for binding purposes.

The degree of heat and rapidity with which the maximum temperature of the outer layer is attained affects the coking properties of some kinds of coal, and some of the South Staffordshire coals, which when slowly heated yield a friable mass useless as coke, will, when heated rapidly to a high temperature out of contact with air, yield a hard coke. This is due to the hydrocarbons all escaping as gases and vapours when slowly heated, whilst they are largely decomposed to pitch when they have to pass through an exterior mass of coke at a high temperature, and so yield the necessary binding

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material. Indeed, it is generally found that the coals showing the least caking power must be carbonised quickly at high temperatures if successful results are to be obtained.

With highly bituminous coals like the Durham and Yorkshire, on the other hand, quick heating would lead to such frothing and swelling of the mass, owing to the large volume of the gases liberated, that it is difficult to carbonise them in any of the narrow-chamber ovens, and when we are blaming the North Country coke-makers for not adopting the more modern forms of oven and by-product recovery plant, we should bear in mind that it is because they find the beehive oven far superior for the class of coal on which they have to work.

When the idea of coking coal first arose, as might be expected, the same methods as in charcoal burning were employed, and heaps of coal were ignited on the ground and the combustion checked by coating with damp coal-dust. A small advance was soon made by building a brick shaft or chimney with openings in the side to allow the passage into the shaft of the gases and volatile vapours issuing from the heap of coal piled around it, and so arranged that the largest coal was nearest the middle. The mass was ignited by burning coal introduced into the shaft, and air inlets were made along the ground into the heap, the combustion being afterwards checked by coal-dust, ashes, etc., spread over the outside. Such a method of carbonising was most wasteful, but produced a good coke where a certain quantity of volatile matter was not a drawback, and "meiler coke," as it was called, is still made on a small scale.

In these processes the heat was given partly by the combustion of some of the coal, and partly by the gases and vapours, and the meiler heaps soon began to be displaced by "oven" coking, which gave a more uniform product and a larger yield of coke.

The early ovens were heated entirely by the combustion of the vapours and gases, together with a small proportion of the coal within the oven, no external heat being employed. These ovens, called "beehive ovens," on account of their domed tops, were 12 ft. wide by 10 ft. deep, and held a charge 10 ft. in depth; the walls were 2 ft. thick, and the ovens were built in groups to retain heat and minimise brickwork. They had a hole in the top of the dome $2\frac{1}{2}$ ft. in diameter, which could be closed by a plate, and an opening in front for charging or drawing, fitted with a sliding door in an iron frame, the door being provided generally with air inlets adjustable at will. The charge could be introduced either through the hole at the top or by the door, but it was found that the coke was of more even density if charged by the door, as when shot in from the top a dense mass of smalls was formed under the hole, which carbonised more slowly than the rest, and so gave a less uniform quality of coke.

In Silesia ovens of much the same kind were employed, but the top was kept closed, a little air was admitted at the bottom and sides, and the gases and vapours were led by a side tube into a tank of water, where the tar condensed and the gas escaped.

In both these forms of oven the new charge introduced fired from the bottom if the structure remained hot enough from the last charge, but as soon as the gas began to be evolved it burnt above the charge, and the heat spreading downwards through the mass continued the carbonisation, the completion of the action taking eighty-four to ninety-six hours per charge of seven tons; at the end of this period the top cover is put on and the oven is allowed to cool down for twelve hours; the coke is then drawn by rakes and quenched with water.

The beehive oven still rules supreme in Durham, Scotland, and America, and the latest form utilises a portion of the waste heat, to do which the ovens are built back to back with a flue between them, the suck of a chimney drawing the hot products of combustion and incompletely-burnt gases through the furnace space of a Lancashire boiler, and so utilising them for raising steam.

Many more alterations have taken place in coke ovens than with gas retorts, and in dealing with the earlier forms I can only glance at those that have proved most successful and were the forerunners of the present systems, which have now settled down to the beehive as the survival of the internally-fired oven, the only remaining rival to the externally-fired by-product recovery systems.

Many forms of coke oven were introduced in the sixties and seventies, the two most interesting being the Coppée and the Appolt, the former being the forerunner of the present recovery plant, and the latter of the modern vertical retort.

In the Coppée ovens the carbonising chambers were long and narrow, with sides slightly tapering from back to front, and about 3 ft. 6 ins. high. Crushed coal was fed into them from the top, and was carbonised by the combustion of the gases evolved from the coal, which escaped

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through openings in the side into flues between the chambers, where it met an air supply and burnt, heating the sides of the chamber. The ovens were built in batches and were charged in rotation, so as to equalise as far as possible the heating value of the escaping gas, which is large in volume and high in calorific value during the first half of the carbonising period, and rapidly falls during the second, and when the action was completed the coke was pushed out from the oven by a ram, both ends of the oven being closed by doors.

These ovens were introduced at Chapeltown, near Sheffield, in the early seventies, and about the same time at Ebbw Vale, and contain many of the characteristics found in the modern recovery plant ovens.

The Appolt oven consisted of a rectangular structure containing twelve coking chambers or built-up rectangular retorts, having a top section of 3 ft. 8 ins. by 13 ins., and a bottom section 4 ft. by 1 ft. 6 ins., and between the chambers flues varying with the taper of the retorts. Vents in the side walls of the retorts allow the gases and vapours to pass into the flues, where, meeting the air supply, they burn and yield the necessary temperature.

The retorts were fitted with doors at top and bottom, so that they could be fed and discharged by gravity. These ovens were used as early as 1857 in the collieries of the Pas de Calais, and the large heating surface constituted a great advance on any previous form of oven.

About the sixties various attempts were made to introduce ovens, from which it would be possible to collect some of the by-products, but no very successful result was obtained until about 1879, when Simon and Carves introduced a recovery plant in which, taking the Coppée form of oven, they closed the side exits for the gas into the flues, and led it off by a dip pipe and hydraulic main to condensers and scrubbers, which extracted the tar and ammonia, the gas being led back to the ovens and burnt in the flues to heat the chambers.

Soon after this, ovens of the same character were introduced by Dr. Otto, which differ from the Simon-Carves plant chiefly in the arrangement of the combustion and heating flues, and in making up for the loss of heat due to removing, cooling and scrubbing the gas before combustion, by using Siemens regenerators to extract the heat from the flue gases and highly preheat the air used in the combustion.

During the past thirty years many improvements have been made in the earlier forms of recovery plant coke ovens, and at the present time only half the gas produced in the carbonisation is needed for firing the ovens. This has led to attempts being made so to arrange the working of the plants as to fit them for the production of the gas supply for large towns, the economies incidental to working with large charges offering an important reduction in the cost of coal gas, and as soon as legislature abolishes the absurd trammels that bind the English gas-maker to a standard of illuminating value, which means nothing, and adopts a standard of heating power, which means everything, some advance may be made in this direction in localities where there is a good market for metallurgical coke.

In spite, however, of the enormous economies in coal, ammonia and tar products, and improvement in atmospheric conditions brought about by the recovery plant, less than one-third of the coal used for coking is carbonised in such ovens the old beehive oven still holding its own in the north of England, polluting the air and wasting the commercial assets of the country to an even greater extent than it did in the first half of the last century, when it had the field to itself—and to explain this extraordinary state of things we must look beyond our insular prejudice and inertia.

The real cause is, as we have seen, that the very "fat" gas coals of the northern fields do not lend themselves to carbonisation in narrow chambers or vertical retorts filled to the utmost by ram or gravity. The great rapidity of evolution of the gas during early periods of the carbonisation leads to such frothing up and swelling of the semi-fused mass on the exterior of the charge that trouble ensues.

Coke varies very much, not only in its chemical and physical characteristics, but also in external appearance. It may generally be accepted that with the same kind of coal the higher the temperature, and the longer the exposure of the coke to it, the harder, more dense and less easily combustible will it be, whilst the appearance is largely conditioned by the method of carbonisation.

In the beehive oven, where most of the heating of the mass is from the top, the escaping gases from the carbonising coal have to pass upwards through the whole mass of red-hot coke above, contact with which decomposes the hydrocarbons and deposits the carbon in almost metallic-looking films throughout the mass, and this gives the bright light grey surface that used to be so highly prized in the beehive coke. On

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the other hand, if the gases are drawn away so as to prevent as far as possible excess of surface contact and pressure, this silvery appearance is not produced, and the coke looks black and dead, as is seen in gas coke and also to a less extent in recovery oven coke.

Some observers claim that this deposition in bright films is characteristic of the decomposition of methane, and is given only by this particular gas, but the difference in the form of the deposited carbon is due to whether it has been decomposed by radiant heat or contact heat. If an easily decomposed hydrocarbon like acetylene is heated by passing between the walls of a very highly-heated tube placed vertically to lessen contact as far as possible, the radiant heat is sufficient to decompose it, and the carbon is deposited as a cloud, but where the hydrocarbon is more resistent and comes in actual contact with the heated surface, then the carbon is deposited in a dense form as a film of great density, which in time builds up masses of retort carbon, and it is only when the film is very thin that the bright appearance is produced. The duller surface of recovery oven coke gave rise to great prejudice against it in the minds of the iron smelters when recovery plant was first introduced, but this was probably caused by the fact that until the recovery plant was perfected—the heat being applied from the outside of the oven instead of the inside, as with beehive ovens—the coke was not so thoroughly carbonised, was softer, and too easily attacked by the carbon dioxide in the blast furnace, and so not so strong or so economical in practice.

In most oven carbonisation the face of the coke nearest the hot wall of the furnace shows a curious undulated surface, consisting of discs 6 ins. to 8 ins. in diameter, and higher at the centre than at the periphery—these are generally known as "cauliflower heads" by the coke burners, and crevices of cleavage run into the mass from the lowest point to the area which was last heated to the fuel temperature in the carbonising process. So regular are these appearances, and so like the columnar structure found in some formations, that they have sometimes been spoken of as if they represented a form of crystallisation, which is, of course, wrong, and they appear to be formed from the escape of gases, which causes the whole mass to swell; after the first few hours this ceases, and a general contraction of the whole body takes place, which being fairly even in every direction fissures the coke in circular masses. If the coke is drawn when the volatile matter just ceases to come off, the heads are not found, but the crevices are there. The coke, however, is left heated to its highest temperature for a considerable period to harden it, and this causes further shrinkage, which, taking place mostly where the crevices have been formed, owing to the heat entering the mass most easily at these points, leaves the central portion between the cracks standing up a fraction of an inch above the densest parts.

Near the doors of the oven, black, dull-looking masses of coke are often found, resembling gas coke, and known as "black heads"; these are formed by the coke at this point not being sufficiently heated to complete properly the carbonisation.

As a rule it is found that the higher the temperature at which the oven has been worked, the more thorough has been the decomposition of the hydrocarbon gases and vapours passing through the red-hot coke, and the carbon so deposited increases the yield. High temperature and long exposure to the heat after carbonisation is finished also render the coke harder, denser, and less easily ignited.

The composition of the coal has so great an influence on the yield of coke, that any comparisons of the percentage yield by the various forms of oven are bound to be misleading, but the alterations from the earlier forms of oven to the modern oven may be taken as representing a 10 to 12 per cent. greater yield of coke.

Taking it very roughly, a good caking coal containing 87 per cent. of carbon would yield:—

Carbonised in heaps	61 per cent.
,, ,, beehive ovens . .	64 ,,
,, ,, Appolt and Coppée	68 ,,
,, ,, modern recovery ovens	68–77 ,,

whilst the by-products, tar and sulphate of ammonia, also form an important asset.

The improvements in the recovery ovens since their first inception have been largely in the arrangement of the flues for heating the sides of the chambers, the superiority of vertical over horizontal flues being now generally admitted, and allowing the necessary temperature to be attained with a consumption of less than half the gas produced by the carbonisation.

A great difficulty that was found was to get even and continuous heating of the chamber walls, as when in the early Hoffman ovens the Siemens regenerative principle was adopted, the alternate application of heat to only one-half

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the chamber wall, the heating being alternated every half-hour, gave fluctuations in temperature which affected the carbonisation and strained the brickwork; and this same trouble was found in the United Otto and Koppers ovens.

In his later oven, introduced in 1905, Dr. Otto doubled the number of regenerators, so as to reverse alternately in four sections, whilst Coppée in his newest type makes the reversal in five sets out of ten sets of flues, and Collin extends the reversal to alternate flues, thus ensuring the most even temperature.

Other alterations have been made in the handling arrangements and in the plant for the recovery of the by-products, which are now nearly equal in quantity to those obtained in gas manufacture, so that, as far as the products of the carbonisation go, we may state the approximate performances of the two methods as being:—

	Coke.	Gas.	
Gas making .	13 cwt. inferior coke, less 2·6 for heating.	12,500 cubic feet, 15 candle-power	Tar, sulphate of ammonia, cyanogen—about equal.
Coke making .	14·2 cwt. superior coke .	9,500 cubic feet, 10 candle-power, less 4,500 for heating.	

EXPERIMENTS ON THE STRENGTH AND FATIGUE PROPERTIES OF WELDED JOINTS IN IRON AND STEEL.*

These experiments were undertaken at the suggestion of Sir John Wolfe Barry in 1908, the object being to obtain a comparison of certain properties of welded joints—made by different processes and by different makers—with the corresponding properties of the unwelded material from which the joints were made. It was hoped that by this means some estimate of the general reliability and efficiency of modern welding processes might be arrived at. In order to obtain material for the work, a circular letter was sent from the National Physical Laboratory to various engineers, inviting them to submit specimens of welded joints for testing. Sixteen firms responded to this invitation, and the total number of welded joints received was 167. The method of welding and treatment of the joints was left entirely to the makers, the only condition being that all specimens should be made from bars 1¼ inch in diameter. The tests to which the joints were subjected were: first, a tensile test, and secondly, a fatigue test by the Wöhler method. The former included determinations of the elastic limit, the yield point, the maximum stress, the total elongation, and the general and local elongations.

For the rapid carrying out of the fatigue tests a machine was constructed in which the specimen was rotated at a speed of 2,200 revolutions per minute. Owing to the results of a previous investigator with another type of machine having shown a decided reduction of fatigue strength with increased rapidity of stress alternation, preliminary experiments were carried out to determine the amount of this effect for the particular type of machine used. The results showed that for speeds of 200 and 2,200 reversals per minute there was practically no difference in the fatigue strength. The assumption was therefore made that the apparent reduction of fatigue strength with rapidity of alternation in the case referred to was a characteristic of the machine used.

The mean results of the tensile tests on the welded joints, expressed as a percentage of the strength of the original material from which the joints were made, were:—

Hand-welded iron	89·3 per cent.
Hand-welded steel	81·6 ,,
Electrically-welded iron . .	89·2 ,,
Electrically-welded steel . .	93·4 ,,

Joints made by the oxy-acetylene process were also submitted by two makers, but the results were not comparable with those obtained by the hand or electric processes.

The various determinations made in the tensile tests showed a distinct want of uniformity in the material in the region of a weld, but the results of the fatigue tests proved that this does not materially affect its resistance to reversals of stress. When failure under alternating stresses of low value takes place, it is invariably due to a defect in the actual weld itself. The number of defective joints which were discovered in the whole investigation, however, leads to the broad conclusion that in important work, where the failure of any particular welded joint may involve serious damage to the structure, the subjection of each joint to a proof load is still desirable.

* Abstract of a paper read by T. E. Stanton, D.Sc., M.Inst.C.E., and J. R. Pannell, at the Institution of Civil Engineers.

HOME INDUSTRIES.

The Industrial Unrest.—The year goes out with general unrest in the labour world. The Master Cotton Spinners and Weavers of North and North-East Lancashire have met the demand of the weavers' trade union for the employment of only trade unionists, by deciding on a lock-out. The members of the association own 420,000 looms, and employ about 160,000 workpeople, of whom some 140,000 are weavers. The cotton waste manufacturers, who have decided to join hands in the dispute with the master weavers, control 300,000

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spindles and over 10,000 looms, and employ about 6,000 workers. Although the lock-out does not directly affect the spinning mills of South and South-East Lancashire, they cannot go on working for an indefinite time if the weaving sheds are not absorbing their output. It is earnestly to be hoped that the threatened lock-out may be short, but at the moment the outlook is not promising, the trade union weavers believing that in the present profitable state of the trade the employers will not hold out very long. On the other hand, the employers are said to be determined not to be coerced, and to insist upon their right to engage those who are honest, diligent, and skilled, without imposing upon them any such test as that involved in the present action of the operatives' unions. The crisis in the coal trade is not over, and little progress seems to have been made in the fixing of a minimum wage, and in the payment for abnormal places. In Dundee, the stoppage due to the carters' and dockers' strike, which made 30,000 workers idle, is over, but the dispute has been bitter and prolonged. In other industries there is discontent, which may at any moment become acute, and though these trade difficulties have a way of settling themselves unexpectedly, the outlook for the New Year, as bearing upon the relations of masters and men, cannot, as matters stand, be said to be other than very disturbing.

Cotton Spinning Profits.—Mr. William Tattersall has just published his annual analysis of trading results of Lancashire cotton spinning companies. The figures cover the twelve months ended November 30th last, and relate to seventy-six mills with a share capital of £2,806,798, and loans of £1,394,792, and show that, though the results are better than they were in the preceding twelve months, they are anything but satisfactory. The value of the machinery, including plant, of the seventy-six mills amounts to £3,288,317, and the total spindleage is 6,570,532, there being 2,687,348 twist and 3,883,184 weft spindles. Of the seventy-six companies, forty-five made a total profit of £79,724, and thirty-one report a total loss of £48,711. The profit on share capital works out at a little more than one per cent. per annum, while the gain on share and loan capital combined is three-quarters per cent. per annum. The result is very poor, but in the previous year the loss on share capital was over 10 per cent. per annum, and on share and loan capital combined over 7 per cent. per annum. Given the avoidance of labour troubles, the current year promises much better. For the last three months spinners have been doing a remunerative trade, and satisfactory profits may be anticipated.

A Great Shipping Combination.—A few weeks ago the shares of the Union-Castle Mail Steamship Company might have been bought at about £13, at the end of last week they stood at £28. This immense advance in price is of course due to the official announcement that the Royal Mail Company and the Elder Dempster Company have purchased the assets of the company, thereby putting a total of about 1,300,000 tons of shipping more or less under the control of the Royal Mail Company, and making it the largest shipping company in the world, its tonnage exceeding by about 150,000 tons that of the International Mercantile Marine Company. The terms upon which the Union-Castle shareholders are to part with their shares will seem strangely generous to those who did not know that the shares have been in the past considerably undervalued, the balance-sheet and profit and loss account not disclosing the real position, which would have allowed much larger dividends. And so it comes to pass that the Union-Castle shares of £10 each are to be taken over on the basis of £32 10*s*. per share, while in respect of the year ended December 31st last a dividend of 4¾ per cent. is to be paid. A condition of the purchase is that Messrs. Donald Currie and Co. resign the managership, and undertake not to be interested as owners, directors, or managers in any competing line of steamers. As compensation they are to receive £700,000, out of which they will pay the vendors' costs in relation to the sale of the shares, and contribute £50,000 to the pension fund of the company. The Royal Mail Company and Elder Dempster and Co. will have to find £4,781,653 in cash to carry out the purchase, and it is not known as yet how it is proposed to raise this sum, but in one way or another the capital of the Royal Mail Company, which now, including debenture stock, stands at £3,700,000 will have to be increased to £6,250,000, assuming it has only to provide one-half of the purchase price; but it is believed that whilst the present prosperous condition of the shipping trade lasts the net profits on the share capital of the combination will be very substantial, even if the company loses the South African Government's mail contract, which means £135,000 per annum.

Cement Combination.—It is long since the cement industry was in a satisfactory condition. There are too many companies engaged in the trade, and an attempt is being made to consolidate the industry in a few hands, with the object of putting an end to the reckless cutting and violent fluctuations in price which have done so much to injure the business in the past. For this purpose, the British Portland Cement Manufacturers (Limited) has been formed, with a share capital that now stands at nearly £3,000,000, and with power to issue debenture stock dependent upon the amount of the issued share capital. The company will take over and amalgamate a large number of cement works and businesses, including the largest undertakings outside the Associated Company, with which it will have a working agreement. The consolidation of competing interests is expected to result in more efficient organisation and increased economy of working. Existing works will be improved, in some cases more up-to-date plant will be put in, and much money will be saved in

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transport charges. For example, the Thames and Medway works have been in the habit of sending large quantities of cement into districts which can be much more easily supplied direct from one of the local works, and these works will be included in the new organisation. It is believed that those who have the project in hand can command the financial resources necessary to carry it to a successful issue.

A Cotton-Picking Machine.—Dr. Fischer has just given the Technical Commission of the German Colonial Agricultural Committee reasons for the conclusion that the Campbell cotton-picking machine has great commercial value. He states that one machine can easily pick 5,000 lbs. of cotton per day, and under favourable conditions as much as 10,000 lbs., whilst the machine only requires a man and a youth to work it. After estimating all working costs, and allowing for depreciation, Dr. Fischer estimates that the picking cost is about 1*s.* 5*d.* per cwt. as against 4*s.* 2*d.* per cwt. for hand labour. Dr. Fischer suggests making large-scale experiments with the machine in the German African colonial cotton-fields, but he admits that it may not prove so suitable for the class of cotton grown there as in America. The price of the machine f.o.b. New York is put at £1,000, whilst the weight is about 4½ tons. The makers are the Price-Campbell Cotton-Pickers Corporation, and they expect to produce 12,000 machines during the next four years. If the machine can really do what is claimed for it, its importance to the cotton industry is demonstrable.

Flannelette.—Makers of flannelette were considerably perturbed by the announcement that a Bill before the Commonwealth Parliament proposed to subject the ordinary kinds of flannelette to a duty of 20 per cent. *ad valorem*, whilst allowing flannelette rendered non-inflammable by some chemical process to come in free. The manufacturers understood that the test for inflammability was one that no cotton cloth could have successfully withstood, and the consequent alarm of makers is intelligible. There is quite a large trade with Australia in these goods, and the introduction of the Bill was followed by many "stop" orders. Fortunately, the proposal has been dropped, doubtless owing to the representations of the Australian importing houses to the Commonwealth Government.

Malleable Iron.—It is expected that the protracted negotiations among the Scottish malleable iron makers for the amalgamation of their businesses will be brought to a finish at a meeting to be held in Glasgow this week. One of the difficulties in the way of the combination is the question of the valuation of the works of the respective makers, who number seventeen, and whose interests are not all the same. Some of them produce other classes of material, and they have raised many difficulties. It was only in April last that the Association of Scottish Malleable Iron Makers came to an end, and it was understood that the rupture of the combination was due to illicit undercutting of prices by members of the association.

Improvements in Laundry Processes.—For some years the leading German passenger-carrying ships have been provided with the electrolytic system for disinfecting linen, and a year ago the Cunard Steamship Company fitted up their laundry at Liverpool with two "Manchester" electrolysers. The White Star line has now decided to instal a similar plant, and it may be expected that the electrolytic sterilisation of linen in public laundries will soon be general.

CORRESPONDENCE.

THE FISHERIES OF BENGAL.

As an old resident of Calcutta I listened to Dr. Jenkins's interesting paper on the Fisheries of Bengal (reported in the *Journal* of December 22nd) with the deepest interest. He is to be congratulated upon placing on record a valuable account of the scientific results of the many voyages of the "Golden Crown." These voyages were discontinued, however, not from any inability to obtain a large and varied supply of fish from parts of the Bay often far distant from the city, and bringing it safely and in good condition to land, but from the fact that after it left the steam-trawler the storage and disposal of the haul were dealt with by the authorities concerned upon unbusinesslike lines. The ventures so ably conducted by Dr. Jenkins and his staff of practical men were rendered largely abortive for practical purposes by reason of the delay in getting the fish on to the market. I believe a substantial portion of each supply was carted to a place called Balliaghatta, for cold storage on the premises there of a local ice manufacturing concern, who happen to possess the necessary refrigerating plant. Balliaghatta is a considerable distance beyond Scaldah, which again is well removed from the great market centres. By the time the fish had travelled miles and miles from the Hooghly to the ice factory, and thence back to the markets for the consumer at the breakfast-tables of hotels, steamers, and private residences, under the fierce climatic conditions of a tropical district, it had often ceased to be palatable, and wise men took to avoiding it with a unanimity born of unpleasant experience. I once saw a small mountain of it being carted away for manure. No doubt the native fishing industry, considering their craft more or less in danger, succeeded in persuading the khausamahs, bobachees, khitmutghurs, and others, who had the ultimate handling of the fish for the table, to find it worth their while to accentuate the difficulties

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of land transport and distribution, and thus to render the wares of the "Golden Crown" unpopular; but apart from this, the absence of sensible arrangements for the disposal for practical use of the costly hauls was widely commented on. The ship may be said to have been lost for the sake of the proverbial "ha'p'orth of tar." The fish were not primarily wanted for the show-cases of the India Museum, they were wanted for breakfast, and the failure to realise this accounts for the relegation of the activities of the "Golden Crown" to fresh shoals and channels new, to the vast delight and profit of the native fishing fraternity, who deserve all they get, for they work hard for it.

Dr. Jenkins's efforts were eminently successful so long as his control over the catch held. Their apparent failure in the end arose from the lack of foresight essential to the putting through of so bold an experiment by the Department he served.

WILMOT CORFIELD.

OBITUARY.

SIR FRANCIS SHARP POWELL, BART.—Sir Francis Sharp Powell died at his residence, Horton Hall, Bradford, on the 24th inst., at the age of eighty-four. After attending the Grammar Schools of his native town, Wigan, and Sedbergh, he proceeded to St. John's College, Cambridge, of which he was elected a Fellow in 1851. He was then called to the Bar, and practised on the Northern Circuit for a few years. In 1857 he was returned as M.P. for Wigan, which he represented till 1859, when he was defeated. During the next twenty-five years, Sir Francis fought a great many elections—during his whole career it is believed that he fought more elections than any other Member of Parliament. For a time he represented the borough of Cambridge; on losing this seat he stood unsuccessfully for Stalybridge. In 1872 he was elected for the North-West Riding of Yorkshire—a seat which he only retained for two years. He also stood for one of the divisions of Manchester, but was again defeated. In 1881 he returned to Wigan and won the seat, but the election was declared void on petition, and the writ was suspended for a time. In 1885, however, his fortune turned; he was again elected for his native town, and he continued to represent it—though not without contested elections in 1886, 1892, 1895, 1900, and 1906—until his retirement from public life in 1909.

A staunch Conservative, Sir Francis was a keen supporter of denominational education; he contributed liberally to the cause of Church extension, and he built All Saints' Church, Bradford, and its school, at a cost of some £30,000. He was for many years Chairman of Governors of Sedbergh School. A baronetcy was conferred on him in 1892, and ten years later he was elected an honorary Freeman of Bradford. He was among the oldest members of the Royal Society of Arts, having been elected in 1854.

JAMES AITCHISON.—Mr. James Aitchison, the founder of the well-known firm of Messrs. Aitchison and Co., opticians, died on the 22nd inst., in his fifty-second year. A liveryman of the Spectacle Makers' Company, he was keenly interested in encouraging study and research among members of the optical trade; he was one of the founders of the Optical Society, and it was largely through his exertions that technical classes for opticians were established at the Northampton Institute, Clerkenwell. He also took a prominent part in calling the Optical Convention in 1905, and he was treasurer of the guarantee fund for the Optical Convention to be held in 1912. Mr. Aitchison joined the Royal Society of Arts in 1902.

GENERAL NOTES.

METALWORK AT THE VICTORIA AND ALBERT MUSEUM.—The Department of Metalwork has recently made several important acquisitions. Chief among them is a serpentine tankard with silver mounts, dating from the reign of James I. It has a peculiar interest, from the fact that its form is transitional between the slender domed-lid tankard of the previous century and the stouter form of a later period. The decoration shows no traces of German influence such as would be found on silversmiths' work of Tudor times, but the engraving on the lid recalls the designs of Michel le Blon. The workmanship is of the highest quality, and suggests that the silversmith was one of the foremost craftsmen of his day. The tankard is exhibited in the case of new acquisitions in Room 26.

A pre-Reformation English chalice and paten, also acquired recently, are exhibited in the same case; they date from the fifteenth century, and are of silver parcel-gilt. The centre of the paten is engraved with the face of Christ, and the foot of the chalice with the Crucifixion. The number of existing pre-Reformation chalices is small, and the one acquired by the museum is valuable, not only for its rarity, but also for its excellence of design.

A silver sweetmeat dish, with hall-mark for 1633, in the same case, affords a good example of a type of work produced in England in the time of Charles I. and the Commonwealth; similar pieces are to be found in use as alms dishes in churches, but as the period of their production lasted only some thirty years, they are naturally rare. A circular silver dish, with escalloped border, illustrates the earlier style of the French silversmiths, who left their country on account of the revocation of the Edict of Nantes and settled in England. The bowl is the work of Isaac Liger, and bears the London hall-mark for 1719. It is delicately engraved with ornament in Louis XIV. style. There is also exhibited in this case a Spanish casket, the panels of which are decorated in repoussé with bold strapwork, and framed

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in richly gilded bronze—a characteristic example of the vigorous work of the first half of the seventeenth century. In Room 39 several cases are devoted to the exhibition of a collection of over two hundred pieces of Sheffield plate. With the exception of a few pieces of late date, illustrating the development of the manufacture, and two or three pieces of foreign make, valuable for comparison, they represent the finest period of the manufacture—the second half of the eighteenth century. The collection includes a large number of examples of the pierced work for which the Sheffield makers were celebrated. The perfection of form and decoration shown in these productions almost surpasses what is found in solid silver of the period, and can only be explained by the collaboration of designers of first-rate ability with very highly skilled craftsmen. The department has also acquired a small, but very choice, collection of Japanese swords, formerly in the collection of Mr. Alfred Dobrée. It is temporarily shown in the second sword-case in Room 16, and includes unmounted blades by perhaps the most famous of Japanese swordsmiths, Masamune (died 1344), as well as by Umetada Hiōju (about 1650), and other smiths of hardly less note. There is also a superb set of fittings for a blade, including a scabbard of the rare green lacquer; the metal mounts, decorated each with a tiger, are in the finest eighteenth century style. In the same room is exhibited a series of over 300 Japanese sword-guards (*tsuba*), acquired from the Hawkshaw Collection. It illustrates the varieties of material and methods of workmanship, and of design and style, characteristic of the sixty or more distinct schools of craftsmen who were engaged over a period of nearly four centuries in making sword-furniture. Several ancient Chinese bronzes have been added lately to the collection, including a wine-bottle, intended to be carried on campaign, the lid forming a cup; it dates, probably from the Shang Dynasty (1766 to 1122 B.C.). Together with a tripod sacrificial bowl with thick green patina and archaic relief designs, dating probably from the same period, it is shown in Room 12. Two pieces of later date, perhaps of the Han Dynasty (206 B.C. to 221 A.D.), recall the shapes and style of an earlier time. One is a ladle for hand-washing at sacrifices, of very graceful shape, the other a large offering-bowl on three feet, with monster handles, and containing a dedicatory inscription of the usual type. These are also shown in Room 12.

THE GOLDSMITHS', SILVERSMITHS' AND JEWELLERS' ART COUNCIL.—Over sixty prizes, varying in value from £10 10*s*. to 10*s*. 6*d*., are offered by the Goldsmiths', Silversmiths' and Jewellers' Art Council for competition in 1912. First, second and third prizes, of the respective values of £10 10*s*., £5 5*s*. and £2 2*s*., are offered to designers of (1) goldsmiths' work, (2) silversmiths' work, and (3) jewellery. Other prizes, of £5 5*s*., £4 4*s*., £3 3*s*., £2 2*s*. and £1 1*s*., for worked objects are offered to goldsmiths, silversmiths, small workers, jewellers, chasers, engravers (heraldic), ring makers and modellers, and prizes of smaller amounts to apprentices in most of these branches. The funds for the prizes have, in nearly all cases, been provided by the Worshipful Company of Goldsmiths. A travelling scholarship, open to students in the technical schools, will also be offered shortly. Further particulars may be obtained from the Secretary of the Council, 30, Theobald's Road, W.C.

POPULATION OF ITALY.—The results of the last census of Italy have just been published by the Minister of Agriculture, Industry and Commerce. From this, it results that the total population of the kingdom last June amounted to 34,686,653, as compared with 32,475,233 in 1901. This shows an increase of 2,211,420 persons in ten years and four months.

THE EGG TRADE IN GERMANY.—The consumption of eggs in Germany has increased considerably during the last ten years. The number of boxes imported to that country from Austria-Hungary during 1910 amounted to 539,242 as compared with 531,740 of the previous year. From Russia, the number of boxes imported last year was 624,470, against 503,197 in 1909.

THE COMMERCIAL RESOURCES OF TRIPOLI.—Signor Vigoni, a member of the Italian Senate, in a recent conference held at Milan at the Circolo Filologico, gave some interesting particulars respecting the actual condition and resources of Tripoli and Cyrenaica. These provinces—he stated—are not the barren and arid lands they are commonly supposed to be by the general public here (Milan), neither is the climate unsuitable for a European population. On the contrary, natural springs and watercourses are abundant, but no attempt is made by the people to utilise them. Artesian wells, tanks, storage reservoirs and irrigation canals are urgently required. In the rainy season the numerous torrents discharge their floods direct into the sea or into the marshes bordering on the coast, uncared for and uncontrolled. By the construction of well-designed hydraulic works, the whole country might be transformed and large areas of land, now unproductive, rendered fertile and productive. The flora in the numerous oases with which the desert is studded is most luxuriant. Many of these like islands in a sea of sand are of considerable extent, and measure several miles across. The value of an oasis is reckoned in Tripoli by the number of its palm trees. Some oases contain as many as 100,000. The roads are merely caravan tracks, which have existed from time immemorial, unkept and uncared for. Works for the improvement of the ports of Tripoli and Benghazi are required urgently. Considerable quantities of dates and olives are exported from the port of Tripoli, chiefly to Malta, Tunis and England. The cultivation of tobacco, under proper fiscal supervision might become a source of considerable

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revenue to the colony. Tripoli produces oxen, camels and asses, fowls, wool, butter and milk. Game of every description—hares, partridges, quails are plentiful. The tunny and sponge fisheries have also a certain importance. The industries of the country, principally hand-weaving and mat-making are carried on in a very primitive manner. The trade with the interior, across the desert, is declining, although a certain quantity of hides, ivory and ostrich feathers are still brought to the coast by caravans. In Tripoli there are important deposits of sulphur and phosphates. Barley is grown in Cyrenaica, considerable quantities of which are exported to England. At Benghazi, cattle is shipped to Malta and Syracuse, wool to Genoa and Marseilles, and butter to Constantinople. Tripoli and Cyrenaica are sparsely inhabited, and could easily support a population ten times greater than is the case at present.

An Edible Chrysanthemum.—Amongst the numerous varieties of the chrysanthemum cultivated in Japan, there is one which is grown specially for the table. The name of this plant in the language of the country is *Riyori Giku*. The flowers, which are of medium size, yellow or white in colour, are eaten as salad. They require to be boiled, and are said to be much appreciated by the Japanese.

Parcels for Persia.—Attention is directed in Mr. L. Oliphant's report on the trade of Persia, just issued (No. 4796 Annual Series), to the parcel post as a means of extending British trade with Persia. Its advantages are rapidity of arrival in Persia (twenty-one to thirty days from the United Kingdom), and the exemption which it enjoys from Russian customs duties. All other means of communication between Europe and northern and central Persia *via* Russia are handicapped by the fact that no through bill of lading can be obtained for goods passing through Russia, and everything is subject to the ordinary import duty for goods entering Russia, and in addition the Persian customs duties have also to be paid. The parcel post enjoys special treatment in Russia. Parcels for Persia from the United Kingdom cost 3*s.* 9*d.* per 11 lbs. to the Persian frontier, and from there to their destination a charge (fixed by tariff) is levied by the Persian postal administration. Parcels, says Mr. Oliphant, who is Acting Third Secretary to his Majesty's Legation at Teheran, should be packed —on account of the length of the journey and numerous changes of transport—in cases preferably of wood, or wrapped in solid leather (if packed in cloth or similar material the Russian authorities return them to the office of despatch), or they may be packed in zinc or tin hermetically sealed. The latest returns show that the United Kingdom sent 5,296 ordinary parcels and 4,086 registered packets, of the value of £11,099, in 1909; Germany in the same period sending eight times as many ordinary parcels and £11,700 worth of registered goods.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 17. — Cyril Davenport, F.S.A., "Illuminated MSS." Sir Walter Armstrong will preside.

January 24.—William J. Gee, "Hydraulic Separating and Grading."

January 31. — Professor G. W. Osborn Howe, "Recent Progress in Radio-Telegraphy."

February 7.—Leonard Hill, M.B., F.R.S., and Martin Flack, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 18.—The Rev. Walter K. Firminger, B.D., Senior Chaplain, Bengal Establishment, "The Old District Records of Bengal."

February 8. — Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India."

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

April 25.—Walter Saise, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 30.—W. A. Legg, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony, "Irrigation in South Africa."

February 27.—

March 26.—R. H. Barraut, Resident at Jesselton, "British North Borneo."

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Vaughan Cornish, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." Two Lectures.

Syllabus.

Lecture I.—January 22.—The size and speed of ocean waves—The height of waves in lakes, seas, and rivers—The length of waves in lakes, seas, and rivers—The steepness of waves, and strains upon ships—The periodic time of waves, and the rolling of ships—The speed of waves and

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its relation to velocity of wind—The height of waves and its relation to velocity of wind—The time required to develop large waves, and the duration of storms—The length and speed of the swell observed after storms—The probable height of the swell during storms—The relation between the dimensions and path of a cyclonic depression and the nature of the winds produced—The depth in which waves break, and its relation to defence works.

LECTURE II.—JANUARY 29. — The action of waves and tidal currents on sea-beaches and sandbanks—The proper action of waves to drive sand and shingle shoreward—The proper action of waves to drive mud seaward—Special conditions under which the action on sand is reversed—The proper action of the tide to drive shingle in the direction of the flood—The normal removal of shingle from promontories and its accumulation in bays—The exceptional accumulation of shingle in salient positions, *e.g.*, at Dungeness—Groynes—The reason of the graded arrangement of shingle on the Chesil beach—The formation of a sandbank on the up-channel side of a promontory—Sandbanks in estuaries and their arrangement by tidal currents—Their rippled surface as a means of mapping these currents—Their influence on the formation of tidal bores—The struggle between land water and tidal water to arrange the sandbanks in the Severn—The variability of the Severn Bore as determined by these factors—The circumstances which determine the starting point of the Severn Bore.

LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry."

CECIL THOMAS, "Gem Engraving."

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

FRANK WARNER, "Silk."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 1...London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "In Neptune's Kingdom, or the Wonders of Life in the Sea." (Lecture I.)

TUESDAY, JANUARY 2...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Dr. P. Chalmers Mitchell, "The Childhood of Animals." (Lecture III.)

WEDNESDAY, JANUARY 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Mr. C. Vernon Boys, "Soap Bubbles." (Lecture I.)

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "In Neptune's Kingdom, or the Wonders of Life in the Sea." (Lecture II.)

Builders, Koh-i-Noor House, Kingsway, W.C., 4 p.m. Mr. A. W. Gattie, "How to Cheapen Transport."

THURSDAY, JANUARY 4...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Dr. P. Chalmers Mitchell, "The Childhood of Animals." (Lecture IV.)

FRIDAY, JANUARY 5...Geographical, Burlington-gardens, W., 3 p.m. (Juvenile Lecture.) Mr. Julian Grande, "Among the Alps."

London Institution, Finsbury-circus, E.C., 4 p.m. (Juvenile Lecture.) Mr. F. Martin Duncan, "In Neptune's Kingdom, or the Wonders of Life in the Sea." (Lecture III.)

Geologists' Association, University College, W.C., 8 p.m. 1. Messrs. R. H. Chandler and A. L. Leach, "On the High Terrace Gravel and on a Palæolithic Implement Factory, Dartford Heath." 2. Mr. A. L. Leach, "On the London Clay and Bagshot Beds (Passage Beds), and on the Gravel of Shooter's Hill, Kent."

SATURDAY, JANUARY 6...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Dr. P. Chalmers Mitchell, "The Childhood of Animals." (Lecture V.)

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Journal of the Royal Society of Arts.

No. 3,085. VOL. LX.

FRIDAY, JANUARY 5, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 10th, 5 p.m. (Juvenile Lecture.) CHARLES VERNON BOYS, F.R.S., "Soap Bubbles." (Lecture II.)

The lecture will be illustrated by numerous experiments.

Further particulars of the Society's meetings will be found at the end of this number.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

JUVENILE LECTURES.

On Wednesday afternoon, January 3rd, Mr. CHARLES VERNON BOYS, F.R.S., delivered the first lecture of his course on "Soap Bubbles."

After showing how simple it is to blow a soap bubble, and what a beautiful object it is, Mr. Boys explained that the bubble afforded means for making experiments and obtaining valuable nformation in many branches of physical science, and that it afforded most elegant illustrations of difficult branches of mathematics. He hoped to show them many experiments which could not fail to be beautiful if they succeeded, and which illustrated in a pleasing way a considerable variety of physical actions and principles.

Water was shown by a series of experiments to have an elastic "skin"; its surface was stretched with a definite force of a little over three grains to the linear inch. This is made use of by spiders and insects in their daily existence. Other liquids show a similar elastic skin, which, however, except in the case of melted metals, is not so strong. The "tears of wine," and the movements of other liquids due to this cause, were shown. In the case of liquids which do not mix, movements also result; such, for instance, as the spreading of oil on water leading to the stilling of troubled waters.

In the case of soap solution, the strength is only about one-third that of water, and this and the slight variations of the strength due to varying surface concentration, are the reasons why a soap bubble can be blown at all. This is because the skin is weak, not because it is strong. Pure water, which is the strongest transparent liquid in this respect, does not allow bubbles to be blown.

The strength of a soap film was shown by experiments, and the contrast of a soap bubble and a saponine bubble exhibited. The considerations of stability as well as strength were touched upon, and the question was illustrated by means of an experiment with an egg-shell held by a soap film so as to rest upon the edge of a rim, but always so that its greatest cross section lay in the plane of the film. It could then roll or roll and jump when the rim was turned round, but the film prevented it from escaping.

Another illustration of stability was shown, where a spherical bubble blown with oxygen gas, and placed between the poles of an electromagnet, did not show any action of the magnet on the feebly magnetic oxygen, as the spherical bubble was too stable. On drawing this out

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into a cylindrical form, very nearly as great in length as it was in circumference, a condition in which it is nearly unstable, the turning on of the electric current instantly caused the bubble to separate into two, the larger one being between the poles of the magnet.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE CARBONISATION OF COAL.

By Vivian B. Lewes,
Professor of Chemistry, Royal Naval College, Greenwich.

Lecture III.—Delivered December 11th, 1911.

The Thermal Conditions Existing during the Carbonisation of Coal.

Having gained an idea of the results desired in the manufacture of illuminating gas and furnace coke, we can pass on to the thermal conditions existing during carbonisation, and at the outset we are met by the difficulty that little is known as to the heat of formation of coal, and that a variety of opinions exists on this point.

It is evident that, as the composition of coal in a mine will vary not only in different seams but even in the same seam, there is no definite composition, and that nothing can be known as to the heat of formation except by direct determination, which necessitates experimental estimations of so complicated a nature that the introduction of errors is extremely likely to vitiate the results.

Probably the most valuable work done in this direction is to be found in a report presented by M. Euchêne on the thermic reactions which occur during the distillation of coal, given in the Transactions of the International Gas Congress in Paris, 1900, in which he determines the thermo-chemical data coming into play during the distillation of coal in the manufacture of gas, with careful estimations of the heat of formation of the products of the distillation as compared with the heat developed by the fuel needed for the distillation; that is to say, a balance is struck, showing on the one side the heat generated, and on the other the heat expended, the difference found representing the heat of the decomposition of coal.

Mahler also determined the calorific value of a coal and of the products obtained on carbonising it, and both these observers found that the calorific value of the coal exceeded that of the products, that is, that coal is endothermic, and that its decomposition evolves heat; but it is quite clear that in the determination of a factor of this kind, which is dependent upon the difference between two figures obtained from a highly-complicated set of determinations, each with its own source of error, and all tending in the same direction, these will be borne by the resultant, and it is not surprising, therefore, to find that with a coal of the same type Mahler found the heat of decomposition to be + 254·83 calories, whilst Euchêne found it to be + 63·51 calories.

In Mahler's work, the result was arrived at by deducting the heat of combustion of the products from the heat of combustion of the coal, whilst Euchêne's determinations were obtained by taking the difference between the heat supplied and the heat consumed during distillation, so that the difference between these two would be likely to be increased by errors leading in opposite directions.

M. Euchêne has determined in this way the heat liberated during the distillation of three types of coal, these results showing in a striking way that the heat liberated increases in nearly regular ratio with the amount of volatile matter in the coal, and that the more oxygen the coal contains the more endothermic its reaction, a fact which points clearly to its being the oxygen-bearing compounds in the coal which give it its endothermic character.

M. Euchêne, in his experiments, obtained results which may be tabulated as follows:—

Moisture.	Ash.	Carbon.	Hydrogen.	Oxygen.	Volatile Matter.	Heat of Formation. Calories.
2·70	7·06	77·56	4·79	5·94	25·99	+ 12·39
3·31	7·21	76·00	4·78	6·82	28·30	+ 35·98
4·34	8·18	72·08	4·78	8·73	32·17	+ 63·51

It is well known that if a coal be carefully analysed, and its thermal value is then determined in a bomb calorimeter and compared with the thermal value as calculated from the most generally accepted formula from the analysis, the results will be in very good accord as long as one deals with an anthracite or steam coal low in oxygen content, but that directly there

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Analysis of Coals (Dry) and Calorific Value.

Coal.	C.	H.	S.	Ash.	O.+N.	Fixed Carbon.	Volatile Matter.	Calorific Values. Calculated.	Calorific Values. Determined.	Difference taken as Heat of Formation. Calories.
A.	90·09	3·85	0·77	1·68	3·61	91·48	6·84	8567	8629	62
B.	81·02	3·23	0·64	9·50	5·61	80·80	9·70	7527	7713	136
C.	87·79	4·09	0·59	3·14	4·39	82·79	14·08	8425	8617	182
D.	84·07	4·51	0·68	5·69	5·04	73·81	20·50	8241	8394·5	153·5
E.	78·29	4·76	1·48	4·90	10·57	61·10	34·00	7638	8026·5	388·5

is any large amount of oxygen, and therefore highly volatile matter in the coal, the value as determined rapidly rises above the calculated value.

Now, in the calculation, it is presumed that all the hydrogen is in combination with oxygen to form water, so that its heating value is lost to the coal, whilst we know that if coal is decomposed we obtain large volumes of free hydrogen, and that unless the temperature of decomposition is very low, but little water is formed, and the secondary product (tar) contains most of the oxygen as oxygenated hydrocarbons; that is to say, the complex character of the oxygen compounds in the coal and the way in which they break up renders the calculation of thermal value too low.

If this were not so, it might be possible to determine the degree of endothermicity of a coal in this way, and it is interesting to see how figures so obtained agree with those put forward by Mahler and Euchêne.

Brame and Cowan made careful analyses of five samples of dried coal in duplicate, the mean of two analyses of each being taken. Three determinations of the calorific value of each coal in the Mahler bomb were then made, and these being in close agreement the mean of the three tests was taken in each case (see table above).

Now we know that the heat of formation as deduced from these figures will be too high, as the calculation errs on the low side, so that the true heat of formation will be slightly below this value, and we can use this as a rough guide to forming an opinion as to the correctness of Mahler's and Euchêne's figures.

Euchêne found that a coal containing 8·73 per cent. of oxygen and 32·17 per cent. of volatile matter, had a heat of formation of 63·51 calories (114·3 B.Th.U.), whilst Mahler, for the same class of coal, found 254·83 calories (458·7 B.Th.U.), so that Mahler's figure is in accord with that deduced for a coal intermediate between coals E and D as analysed by Brame and Cowan, and is probably a little too high.

Constam and Kolbe made a very fine research upon the carbonisation of typical English coals in 1909,* and determined their calorific value, and also the calorific value of their distillation products, and found that the value of the coal exceeded the heat value of the products to the extent shown in the table given below, in which the heat balance of the products of distillation of the ash-free and dry coal is given in percentages of the heat value of the coal substance.

This shows, as in the other determinations given, that when we get down to a steam coal, *i.e.*, a coal poor in volatile matter and oxygen, its calorific value more nearly approaches that obtained by calculation or by determination of the heat present in the products.

If we now take the Low Main, Barnsley and Hutton Seam coal, and calculate what the loss of heat shown in the table amounts to per

	Description of Coal.	Heat found in Coke.	Heat found in Gas.	Heat found in Tar.	Heat found in Pitch.	Loss of Heat.
I.	Nottingham, bright coal	61·3	22·7	8·4	1·6	6·0
II.	Lancashire, Trencherbone	61·7	22·8	11·0	1·4	3·1
III.	Nottingham, best hard	64·1	20·2	10·0	1·3	4·4
IV.	Kinneil	62·9	22·0	9·5	2·1	3·5
V.	Durham, Low Main Seam	63·7	20·6	9·5	2·2	4·0
VI.	,, Hutton	65·3	22·1	7·7	2·0	2·9
VII.	Yorkshire, Barnsley	70·4	18·3	6·9	1·9	2·5
VIII.	Durham, Ballarat	73·6	18·6	2·5	1·7	3·6
IX.	Welsh, Nixon's Navigation	76·7	16·9	2·9	1·4	2·1

* *Journal of Gas Lighting*, CVII. 698, 1909.

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pound of ash- and water-free coal, we obtain the following results:—

	B.Th.U. per lb.	Loss per cent.	B.Th U.
Low Main . .	15,393	4	615·68
Barnsley . . .	14,792	2·5	369·80
Hutton . . .	15,766	2·9	457·21

and the average of these results would be 480·9 B.Th.U. per pound, and if we take this as due to the endothermicity of the coal, the figure agrees with Mahler's determination, and also with the figure deduced from Brame and Cowan's work.

It seems likely that when the oxygen in the coal falls below 3 per cent., all endothermicity will disappear, or at any rate become negligible, whilst with gas coals of the type most used in England, containing about 32 per cent. of volatile matter and 7 to 8 per cent. of oxygen, it will approximate to 250 calories or 450 B.Th.U. per pound of coal; but all the evidence as to this property in coal is of an unsatisfactory character.

The thermal value of the reactions in the retort will remain the same whether the distillation be carried out in a horizontal, vertical, or inclined retort, in a coke oven or a chamber, and it is chiefly in the setting that the economies have been made which have reduced the carbonising fuel to the figures attained in modern practice.

In the horizontal retort setting quoted above the total heat used would be 1228 + 1884 = 3112. Now, 1 lb. of gas coke gives an average of 14,200 B.Th.U. in its combustion, so would give enough heat to carbonise 4·5 lbs. of coal, or, in other words, the coal would require 21·9 per cent. of its weight of coke to carbonise it, whilst, if the whole of the heat of combustion could be used in the retort, 8·6 per cent. would be sufficient.

A fair idea of the economies that are possible can be obtained by stating the heat used in the setting and retort in percentages:—

		B.Th.U. per lb.	Per cent. of heat used.	
Used in retort	1. Decomposition and distillation	462	15·7	39·3
	2. Escaping in gas and vapours	324	10·4	
	3. In hot coke	442	13·2	
Used in setting	1. Flue gases	1463	47·2	60·7
	2. Radiation and convection	398	12·8	
	3. Ash	23	0·7	

When a coal is carbonised it decomposes into gases and vapours, leaving behind the solid coke, and heat is used up in bringing about the change of state. When 1 lb. of coal is decomposed in the retort the heat used up in the decomposition and distillation amounts to 462 B.Th.U. over and above the heat due to endothermic reactions. The heat withdrawn from the retort by the hot gas and vapours amounts to 324 B.Th.U., and the heat in the red-hot coke when it is drawn accounts for another 442 B.Th.U., so that the heat that has to be actually supplied for the carbonisation is 462 + 324 + 442 = 1228 B.Th.U.

The losses in the setting, however, exceed this, and in an ordinary horizontal bench would be 1,463 B.Th.U. escaping with the flue gases, 398 B.Th.U. lost to the air by radiation and convection, and 23 B.Th.U. in the ash, making in all 1,884 B.Th.U.

so that 39·3 per cent. of the heat is used in the retort, and 60·7 in the setting, the item which overshadows all others being the 47·2 per cent., which escapes up the chimney in the hot flue gases.

It is evident that the first step towards economy is to be found in a better utilisation of the heat in the setting, so as to abstract as far as possible the heat from the products of combustion, and this is done by regeneration, which reduces the flue gases by over 300° C. in temperature, and brings down the loss due to this item from 47·2 to 25·2 per cent., whilst feeding the producers with red-hot coke from the retorts effects a further economy, with the result that the fuel used falls from 21·9 to 14·8 per cent., and even lower.

Under these conditions the percentage of heat used in doing the work of carbonisation would be largely increased, and the chart would be as follows:—

Used in retort	1. Decomposition and distillation	21·4	54·1
	2. Escaping in gas vapours	13·8	
	3. In hot coke	18·9	
Used in setting	1. Flue gases	25·2	45·9
	2. Radiation and convection	19·9	
	3. Ash	0·8	

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so that over one-half the heat is utilised in work.

In the most modern practice, results as low as 10·24 per cent. of the weight of the coal carbonised have been quoted, whilst in vertical retorts and chamber carbonisation 12 to 15 per cent. is the usual figure, these advances being made by utilising hot coke in the producers, more perfect regeneration, and reduction of the radiation.

The factor which endows all carbonisation problems with especial difficulty is that we are dealing with a body of such varying composition that no two samples are alike, whilst the conditions under which we are decomposing them vary from minute to minute.

The conduction of heat through a substance like the walls of a fireclay retort is a determination fraught with many troubles, as the conditions existing in a retort heated in a bench are totally different from those that can be obtained in making experimental determinations in a laboratory. In any calorimetric determination the one side of the test piece is continuously cooled by the calorimeter, whilst the heat poured into the other side is very different in effect to the mass of heated material existing in the flues surrounding the working retort.

The rate at which heat is transmitted under working conditions depends upon the degree of heat in the flue and outer walls of the retort, the higher the temperature the more rapid being the transmission, whilst the difference between the temperature of the outer and inner skin of the retort is a factor of the greatest importance. The greater the difference—*i.e.*, the cooler the inner skin and the mass in contact with it, and the hotter the outer skin in the flue—the more rapidly will the heat pass. Again, the rapidity of transmission varies with the character of the fireclay, with its porosity, and with the temperature and length of time for which it has been baked, so that it is impossible to give any definite figure as to the rate of conductivity or transmission which shall hold good in all cases. Determinations based upon the rate of transmission at comparatively low temperatures may be discarded at once as valueless; but Mr. G. Beilby determined the conducting power of firebrick, and came to the conclusion that one square foot of firebrick, one inch thick, passed 6·59 Centigrade pound units, or 11·86 B.Th.U. per hour for each degree Centigrade of difference between the sides of the brick, when these differences were of the magnitude of 200°–300° C.

S. Wologdine has also determined the rate of conductivity of fireclay, and finds that the heat transmitted through a thickness of 1 metre across an area 1 square metre per hour for a difference of 1° C. varies from 1·07 calories, when the clay has been baked at 1050° C. (1922° F.), to 1·81 calories, when it has been baked at 1300° C. (2372° F.), and that the diagram connecting fall in temperature with thickness of material is a straight line.

My own opinion is that, at the ordinary working temperature of a retort under gasworks conditions, the amount of heat transmitted approximates to 25 B.Th.U. per square foot of surface for each 1° C. difference in the temperature of the outer and inner surface of the retort, and that this is not seriously affected by the thickness of the fireclay, as conduction is so slow with a retort 3 ins. thick that it is probably only the internal portion that is cooled to any great degree when a fresh charge is fed into a properly heated retort, and the mass of fireclay acts as a store of heat, so that the heat has only a short travel.

In a horizontal retort ready for charging, the temperature of the inner walls will approximate to 1000° C. (1832° F.), and the flue temperature to 1100° C. (2012° F.), and the fireclay walls of the retort will conduct the heat at a rate which approaches to 25 B.Th.U. per square foot for each degree Centigrade difference in the two surfaces per hour, so that during the first two hours, when the average temperature of the inner side of the retort walls, cooled by the charge and by the retort having been opened, will not be more than 800° C. (1472° F.), the amount of heat passing through the walls into the charge will be 25 × (1100 – 800) × 7500 B.Th.U. per square foot of surface, whilst by the fifth hour, when the inner side of the wall of the retort has risen to 950° C. (1742° F.), the amount passing will be 25 × (1100 – 950) = 3750 B.Th. U., or only half the amount passed in the earlier period, the average being approximately 5,625 B.Th.U. per hour, which, taking the heat units needed for the actions taking place in the retort as 1,228 B.Th.U. per lb., gives a carbonising value for a six-hour charge of 12 tons per 1,000 square feet of retort surface.

The diminution in the quantity of heat passing through the walls of the retort during the last stages of carbonisation does not affect the rate at which the still uncarbonised core of coal is being heated, as the envelope of coke surrounding it has reached nearly the same temperature as the walls of the retort, and forms a store of heat, whilst in the carbonising

mass during the first part of the distillation the volume of gas evolved is so large that it carries off from the contents of the retort a large proportion of the heat, and so keeps down the temperature of the mass until the later stages of the carbonisation.

It has become the custom to speak of the temperature of carbonisation being high merely because the temperatures in the flues and in contact with the walls of the retort are high, and to speak of the products of high temperature distillation as if the coal had been carbonised at the temperature existing on the retort surface.

It is quite clear, however, that, coal being a bad conductor of heat and coke a worse one, it is only the layer of probably less than an inch thick that is carbonised at anything like the retort temperature, and that the remainder of the charge is distilled at a slowly rising temperature, which attains its maximum only after the volatile products have been practically all driven off.

The real distinction between high heats and lower flue temperatures is that the higher the temperature employed the thicker and hotter will be the layers of coke which the gases and vapours have to traverse in their escape from the inner portions of the charge, and the greater will be their exposure to radiant heat and contact with the highly heated surfaces of the retort in their outward passage from the carbonising mass; the products of the primary action are, in fact, being subjected to secondary decomposition under conditions we neither know nor can control, and this is one of the weakest points in our methods of carbonising for the production of illuminating gas.

We make elaborate tables of the composition of gases and tars produced at various distillation temperatures, but the only information that they give us is what is left undecomposed under unknown and varying conditions, the only certain factor being that the heat was nowhere above that which we are pleased to call the temperature of distillation.

It is evident that if these variations exist in the temperature at which the coal is distilling in the comparatively small charge in the gas retort, they must be accentuated when one comes to deal with carbonisation in bulk as practised in oven and chamber settings, as not only is the travel of the gases and vapours through the red-hot coke much longer, but the rate at which the heat is conducted through the carbonising mass becomes slower as the bulk of the charge increases, whilst the temperature in the crown of the oven during the first half of the time is higher than is found in the gas retort, and this also applies to the temperature in the top layer of the coke.

If the coal is carbonised in a 6 in. diameter tube, filled so that the heat shall be penetrating from every side, there is an almost immediate rise in temperature throughout the mass, owing to the hot gases and vapours passing through the interstices between the pieces of coal, and the coke attains its maximum temperature at the rate of about one inch per hour, so that in three hours, with a wall temperature of 1000° C., the centre of the mass would be at about 950° C., and the carbonisation would be finished. If, however, the tube be increased to 12 ins. in diameter, the rate of conduction is reduced to 0·5 in. per hour, and the same thing takes place with a flat-chamber retort heated from the sides, so that it would take about twelve hours to complete the carbonisation, whilst with further increase in the width of the chamber the rate of travel of the heat grows still less, the passage of the heat being still slower as the distance between the walls of the chamber gets greater.

The result of this is that in by-product recovery coke ovens, and large chamber retorts, the period of carbonisation becomes very long, and the gas has to pass through so much hot coke that the illuminating power is reduced to nine or ten candles.

These rates of passage of heat apply only to vertical retorts or chambers, the sides of which are heated, as bottom heat penetrates the mass rather more quickly owing to convection coming to the aid of conduction, and the upward flow of heated gases raising the temperature in advance of the conducted heat.

Moreover, the rate at which the heat travels in the carbonising mass depends to a great extent on the initial temperature employed, the figures given being attained only when the flues and outer walls of the retort or chamber are heated to about 1100° C. (2012° F.), but if the flue temperature is lowered the transmission of heat becomes lower, and a longer period, therefore, is required for the complete carbonisation; so that if in a 6 in. tube with a wall temperature of 1000° C. (1832° F.) it takes three hours to complete carbonisation, it would take six hours to do the same work with a wall temperature of 500° C. (932° F.). Consequently, in making low temperature coke, such as coalite, in tubular retorts 5½ ins. to 6½ ins. diameter, it takes four hours to drive off two-thirds of the volatile matter that is in the coal.

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The temperature of the coke or coal through which the gas and tar vapours have to pass, and the length of travel they have in reaching the exit from the retort or chamber in which carbonisation is proceeding, are two of the most important factors in determining their decomposition, as it is these which give rise to the secondary reactions that largely determine the final composition of the gas and tar.

Valuable pyrometric observations on the temperatures existing in charges of varying size have been made by Mr. Bond, of Southport, and other observers, from whose work we can deduce the following results as typical.

If an ordinary D-shaped horizontal retort, 18 ins. to 20 ins. wide and 15 ins. high, has a 6 in. charge fed into it, the space from the apex of the crown to the top of the charge will be 9 ins. deep. If now thermo-couples properly protected are placed—(1) at the bottom of the charge, (2) in the centre, and (3) at the top of the charge, we can gain a good idea of the way in which the heat is acting on the coal.

With full heats the coal at the bottom of the retort rapidly heats up, and in fifteen minutes has reached 700° C. (1292° F.), after which its rise in temperature slows down, and it takes two hours to reach 800° C. (1472° F.); after this it heats more rapidly, and attains 1000° C. (1832° F.) at the end of four hours, and then there is practically no rise in the last two hours of carbonisation. The temperature at the top of the charge rises more slowly, and by the end of the second hour is only 740° C. (1364° F.), or 60° cooler than the bottom, and remains at a lower temperature throughout the whole carbonisation. This is not to be wondered at, as although the top flue of the setting is 1150° C. (2102° F.), and the bottom flue barely 1100° C. (2012° F.), the coal at the top of the charge is being heated largely by radiant heat acting across a considerable gas space, whilst the bottom of the charge is in direct contact with the heated bottom, and is taking in heat by conduction.

The thermo-couple in the centre of the charge throws most light upon the course the distillation is taking, and we discover that so great is the heating effect of the gases and vapours passing up from the hot zone at the bottom of the retort, that at the end of the first hour the temperature is only 30° below that of the bottom, 730° C. (1346° F.), whilst in two hours it is at the same temperature, and then falls slightly below it for the rest of the time, the rush of hot gases from the bottom having ceased, and the temperature of the top of the charge equals the centre only after the fourth hour.

Now the fact that differences in temperature are so small throughout the mass, and that during the whole of the period when the bulk of the gas is being evolved the centre of the charge is hotter than the top, points to the gas forcing its way through the pasty mass of distilling coke upwards into the space below the crown of the retort, where it is baked by radiant heat from the mass of fireclay at 1050° C. (1922° F.), and the retort walls at 1050° C., and the coke at from 700° to 1000° C. (1292° to 1832° F.), are also in surface contact with it.

The passage of the gas through the pasty coke causes considerable swelling during the first hours of distillation, and when the shrinkage in the charge of coke takes place during the last two hours, the top portion, presumably carbonised by radiant heat from the top of the retort, shrinks over a smaller depth than the bottom and large portion, so that when the charge comes to be drawn there is found to be a fissure running horizontally between the upper and lower portions, but nearer to the top, from which vertical cracks branch to the top and bottom of the charge.

We are at present dealing only with the thermal conditions existing during carbonisation, but when we come to study the more chemical side of the actions taking place, we shall see that such methods are the most brutal form of distillation—high heats and small charges certainly mean high makes of gas, but got at the expense of all the other by-products, and bringing in their train all the troubles of stopped ascension pipes, carbonised retorts, ruined tar, and poor coke. If, instead of using a 6 in. charge in such a retort, it be filled with coal as nearly as a horizontal retort can be filled—that is, to within two or three inches of the apex of the crown of the retort, and the same temperatures as before are used in the setting, you approach to the same conditions that obtain in vertical retorts, which are entirely filled, and quite different results are obtained.

The improved results are by most observers ascribed to the doing away with the baking chamber above the charge, radiant and contact heat being credited with the formation of free carbon and naphthalene, which have been the chief curses that have accompanied the raising of temperatures with small charges to increase the gas volume obtained.

The determination of temperature as before in the charge shows that filling the retort does

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a great deal more than this, however. In the first place, in order properly to carbonise the charge, the heating has to continue from eight to twelve hours, instead of six, and the heat is poured into the charge in a much more even manner, the rise in temperature at both top and bottom being equal throughout the distillation, and with the top temperature always about 100° C. more than the bottom, truly reflecting the difference in temperature between the top and bottom flues of the setting. Owing to the thickness of the charge having been doubled, the heat advances more slowly into the mass, rendering the coal semi-fluid and pasty in front of it, and so forming the whole centre of the charge into a tube through which a large proportion of the gas finds its way down to the mouth of the retort without having been overheated in the crown.

That this is the true explanation is shown by the thermo-couple in the centre of the charge, which during the first five and a half hours of the distillation rises slowly in temperature at about the same rate as the outer portions, but on a plane 500° C. (932° F.) below them, whilst after this period the central heat rises rapidly, and the same temperature as exists at the bottom of the charge is attained in the eighth hour.

The gas is improved, because only a small portion has to run the gauntlet of overheating; the tar is improved, because a considerable proportion is made at a lower temperature; the coke is improved, because in the earlier half of the distillation a good deal of tar has condensed in the cool zone, and as the temperature rises the more volatile portions redistil, but the least volatile remain and get decomposed only in the last hour of carbonisation, increasing the gas yield, the factor for which the gas-manager at the present time seems prepared to make any sacrifice.

It must be clearly borne in mind that the possibility of filling a horizontal retort to within three inches of the crown, although suggested by Kunath in 1885, is a comparatively new condition, which could only be achieved by the introduction of discharging machinery that would push the charge of coke out of the retort, and that as long as we were dependent upon hand labour to draw the charge it was impossible. Now, however, the introduction of vertical settings allows a more complete filling of the retort by gravity, and easy discharge, so that the question of the route taken by the gas in its escape from the carbonising mass is receiving its full share of attention, and opinions on the subject are by no means unanimous.

Dr. Bueb, to whom we owe the inception of the Dessau vertical retorts, is strongly of opinion that the largest bulk of the escaping gas finds its way through a cool core in the same way that it undoubtedly does in a well-filled horizontal retort; others favour the theory that the major portion passes up the sides, whilst Dr. Harold Colman and many others agree that as the pasty area of the decomposing coal works its way inwards from the walls of the retort to the centre, gas escapes on both sides of it, so that a portion goes up the centre and the remainder through the hot coke or up the walls of the retort. What proportions exist between the gas that takes the cool route and that which is forced to pass through the hot coke cannot be exactly determined, and would vary with every kind of coal, but what we do know beyond doubt is that a large volume of the richest gas comes off from all coals when first heated, so that a large evolution of primary gas will be on the inside of the tube of semi-fused coal, whilst another factor, which would tend to make the gas take the inner route, is that any passing back into the hot zone would be expanded by the temperature, whilst the still pasty coke would offer more resistance to the passage of the gas than the coal, so that pressure would be highest on the hot side and lower on the cool, the probabilities, therefore, being that as long as the central passage is unimpeded the major portion of the gas passes up the centre. The analyses of the gases, however, all show that far too much cracking of the rich hydrocarbons has taken place.

I have had a considerable experience in carbonisation in vertical 5½ in. to 6½ in. tubes at all temperatures, and find that for a considerable period the gas escapes freely up the central core, but a time soon arrives with a column of this thickness in which the least volatile constituents of the tar condense in the central core, and so choke it that the pressure rises to an undue degree in the lower half of the tube, and causes serious leakage at the bottom door of the retort, whilst some gas and tar vapours are forced from the lower half of the charge through the already choked portion and along the walls, and as pressure is the most fertile source of carbon deposits in a retort, this is a serious consideration.

When we are dealing with a well-filled horizontal retort, we have an oblong mass of coal, 18 ins. to 20 ins. wide by 12 ins. thick, and the heat advances so slowly that there is but little fear of choking from tar until the distillation is practically nearly completed, and the same thing

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will be found with chamber retorts, such as have been installed by Mr. Thomas Glover at Norwich. These latter consist of oblong retorts, 3 ft. high, 1 ft. wide, and 21 ft. long, taking 21 cwt. of coal as a charge, which requires twelve hours for its proper carbonisation. In these chambers the course of the heat is manifestly inwards from the sides, which constitute the largest heating area, as is shown by the fracture of the coke on drawing being vertically down the centre. It has been seen that with the horizontal retort the coke on drawing has a horizontal fissure or fracture through the mass, the heat having passed into the charge chiefly from the top and bottom. The fracture in a coke charge is due to tar distilling forward before the advancing heat in the charge, and portions condensing at the coolest spot to be afterwards redistilled as the heat reaches that area of the charge. This takes place during the last two hours of the carbonisation, during which time the remainder of the coke is contracting and becoming denser under the prolonged action of heat, which shows itself by the charge shrinking from the walls, and also from the still soft central layer, leaving the fissure in the finished coke. When the carbonisation is carried out in a tube, the fissure becomes a hole in the centre of the rod of coke, the sides of the hole showing ample signs of the carbonised tar, whilst, if forced from the tube two hours before carbonisation is completed, the core is found to consist of coal and soft pitch.

In coke ovens, in which a large mass of coal is heated from the sides, the fissure (or plane of separation, as it is best called, to distinguish it from the planes of cleavage, which as a rule are nearly at right angles to it) is vertically down the centre when the oven has been properly heated, and the two sides are at the same temperature; but if the two sides are not at the same temperature, the plane of separation is found nearest to the cooler side.

There is a wide difference between coals of very much the same ultimate composition in the way in which they are affected by heat during carbonisation, and the value of the coke produced will largely depend upon the conditions of carbonisation being made to fit the behaviour of the coal—a point to which sufficient attention has not yet been paid in the manufacture of coal gas.

This has made itself felt in the introduction of the vertical retort, in which it is found that certain classes of coal give rise to undue swelling of the charge in the earlier stages of carbonisation, and so lead to choking of the top of the retort.

When horizontals with a 9 in. space above the coal were used it did not matter how much or how little the coal swelled, but with a completely filled vertical retort it becomes a serious matter.

The swelling of a coal during destructive distillation is largely dependent upon its degree of fusibility. If a coal fuses easily, and the products are fairly liquid, the gases escape from it readily by the bursting of the tar bubbles formed, and the swelling is but slight. So also infusible coals, which undergo but little softening, give no trouble in this respect, but coals which yield a tough viscid mass form large bubbles, and give rise to troublesome swelling, which shows itself even more with low temperature carbonisation than with high heats, and this was one of the factors that gave serious trouble in the manufacture of "coalite."

In the manufacture of coal gas in lightly-charged horizontal retorts, not only does the length of travel that the escaping gases have to undergo through red-hot coke vary through the whole process, but the length of time they are exposed to radiant heat in the crown of the retort, and the amount of contact with the highly-heated fireclay surface, also vary to an extent that makes any uniformity of action or result an impossibility.

The products of distillation from the coal near the mouth of the retort, be it horizontal, vertical or sloper, have only a short travel to reach the mouthpiece, and are hurried on by the gas behind them, so that the time given for secondary reactions is curtailed to a fraction of a second, whilst the gas from the end of the retort has nothing to drive it forward, and has to run the gauntlet of surface action and baking to an extent that results in little else than hydrogen and carbon. Between these two limits every degree of secondary reaction is to be traced, and the gas and tar obtained are a mixture of the results of everything from low temperature distillation for a short period to high temperature for a long period.

The temperature of the gas as it reaches the mouthpiece of the retort shows but little of these variations in individual portions of the gas, as they are going on *pro rata* throughout the whole time of carbonisation, and the thermo-couple or thermometer registers merely the mean temperature of the volume of escaping gas, so that as the period of carbonisation proceeds, and the bulk of distilling gases and vapours grows

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smaller, the temperature of the escaping products grows less, although coming from a mass at a higher temperature.

It will be found that at the usual carbonising heats, as soon as the gas begins to escape freely, the temperature at the mouthpiece will be approximately 400° C. (752° F.), and that this will remain fairly constant until the fifth hour, whilst the falling-off in volume during the fifth and sixth hours is reflected by a gradual fall in temperature of about 100° C. (180° F.). As might be expected, the slowing down of the rate of flow of gas and vapour is shown even more by the temperature at the top of the dip-pipe, which rises with the first rush of gas to 120° C. (248° F.), and then steadily falls to about 50° C. (122°F.) by the end of the period of carbonisation.

In the secondary reactions taking place in the retort, pressure plays an important part, and as pressure is being created constantly by the evolution of gas, expansion and decomposition, the maintenance of an even pressure is a matter of great difficulty, and where the dip-pipe and hydraulic main are used, although the retort-house governor may keep the pressure steady in the hydraulic main itself, the escaping gas will be subjected to "throbs" of pressure as the gas forces out the liquid in the dip and escapes into the hydraulic main. When the gas is escaping rapidly, these changes of pressure succeed each other so rapidly that the effect in the retort is a pulsation, whilst as the flow of gas slows down the individual "throbs" become more and more distinct, and short as their duration may be, they add to leakage and to decomposition.

In many works little or no attention is paid to the size of coal used, and the coal as it comes from the truck, barge, or ship goes into the retort, only the lumps so large as to give trouble being broken, and it is manifest that the flow of heat into the mass must be considerably affected. Indeed, in the manufacture of furnace coke uniformity in size in the coal is looked upon as being as important as amount of moisture and other factors of the same kind.

It is clear from these considerations that in the destructive distillation of coal for the manufacture of gas there is no one factor of uniformity in any part of the process, and that to attempt to trace the course taken in the decomposition of a body of unknown structure like coal under such conditions is not likely to meet with much success.

Many observers have attacked the problem of distilling coal at various temperatures, analysing the resulting products with commendable care, preparing curves of convincing character, and launching forth in a sea of theory and conjecture, apparently oblivious of the fact that in each experiment supposed to represent the changes at the particular temperature employed, they were dealing merely with a trace of those particular products diluted with every primary and secondary product formed at all temperatures below it. Some of these researches, like those of Mr. Lewis T. Wright, made as they were on working charges under working conditions in ordinary gasworks plant, are of the greatest possible value, as they represent what actually takes place in gas manufacture, with all its varying conditions, and are a contribution to our knowledge of an importance that cannot be over-estimated, but the class of research that deals with gram weights of material, carbonised under conditions that never have been and never can be attained in practice, are of little interest save from a scientific point of view.

It is clear that to obtain any insight into the actions taking place in the destructive distillation of coal, the quantity and composition of the tar is quite as important as the volume and composition of the gas, and a knowledge of the composition of the coke is also essential.

Long ago it was recognised by the gas-manager that the small coal-testing plants in which 2·24 lbs. of coal were distilled, gave results which did not agree with works' practice, the yield of coke on the small-scale experiment being too low and the tar too high, whilst the gas was generally higher in candle-power. This is due to the whole mass rapidly heating up and the tar vapours distilling out without there being any cooler portion of the charge for them to condense in, so that they yield the minimum of pitch and carbon to the coke, whilst the gas has but little surface contact to degrade it. Constam and Kolbe found that, using 1·1 lb. of coal, the yield of coke was 2·7 per cent. lower and the tar 1·6 per cent. higher than the results given by the same coal when used on a large scale.

When, however, one comes to the use of 2 grams of coal, as has been done by some recent investigators, the results obtained are ludicrously wrong—a Silkstone coal being credited with yielding 16·2 per cent. of tar at 750° C., or over thirty gallons, and 10·9 per cent. at 1050° C., whilst at 450° C. it yields only 4·29 per cent.; in actual practice we know that such a coal yields at 1000° C. about ten gallons, and at 450° C. about twenty-two gallons of tar.

The views I shall have to bring before you in

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the next lecture are based upon the carbonisation of some thousands of tons of coal at low temperatures, and I think afford fairly clear evidence of the actions taking place.

SUDDITE.

Most travellers in the Sudan have observed the thick growth of sedge by which navigation is impeded in the White and Blue Niles above Khartum. For the last four years two Germans and an Englishman—Herr von Rath, Professor Hœring, and Captain Benett-Dampier—have been making experiments with the fibrous material that develops with such rapidity beneath the surface of the water, in the endeavour to manufacture a substance which may take the place of coal.

There is no natural coal in the Sudan, and the high price of imported fuel in the country makes industrial enterprise almost impracticable. The new fuel is called "Suddite," and it is made from the umsoof, grasses, papyrus, etc., which grow under water in the river. The supplies of sudd are immense, there being no less than thirty-five thousand square miles in existence.

If this invention can only be put into working operation, an extraordinary impetus will be given to the trade of the country, the effects of which can hardly be exaggerated. In April, 1911, Captain Benett-Dampier opened an experimental factory for suddite briquettes at Khartum. The Sirdar, Sir Reginald Wingate, and a large number of persons were present at the opening and, in the presence of the guests, a quantity of raw sudd was chopped, dried and pressed into small, compact briquettes suitable for commerce. The Sudan Government had taken a keen interest in the undertaking and had promised a monopoly should the experiments be absolutely successful, and providing it could be proved that a fuel from the soil of the Sudan had actually been found. The Government were anxious that the country should not be discredited by bad finance or unreliable schemes. To satisfy them the Khartum factory was erected. The tests were very exacting, and proved the virtues of "suddite" to be genuine, and Government has granted the concession.

To compare the relative merits of coal and sudd, a steamer was run up the White Nile for a prescribed journey of sixty-five miles on a certain day with the best Welsh coal. Next day the same journey was done with "suddite." With coal the journey was done in seven hours; with "suddite" in seven hours and seven minutes. The cost of coal to the Government at Tewfikieh, where fuel is most in demand for supplying the dredgers maintained in the sudd region for keeping the river channels clear, is 400 piastres, or £4 2*s.* 1*d.* per ton, whereas the suggested sale price of "suddite" to the Government is 22*s.* 6*d.* per ton. As it takes two tons of "suddite" to do the work of one ton of coal, it is at once seen that the reduction in the sum spent in fuel will be almost a half of that now expended. The sudd growth consists of plants of from fifteen to twenty feet high. So rapid is the development that within three weeks of cutting it has again grown to a height of seven and a half feet. After it has been cut it is tied into faggots, made into rafts, and simply floated down the river in the charge of a couple of natives, so that transport expenses are practically nil.

Big "suddite" works are planned for Tewfikieh, many miles down the river. The factory at Khartum is small, and was only built for the experimental tests required by Government. The difficulty at the moment seems to be the cost of transport of the briquettes from the big factory down the river.

The inventors of "suddite" believe that it has immense possibilities. If it can be brought into general use throughout the Sudan as a cheap fuel, there is no reason why that country should not be available for cotton-ginning, rice-milling, and the manufacture of sugar. It should also considerably help the work of irrigation, and so be the means of assisting agriculture.

In a recent interview, Captain Benett-Dampier alluded to a process being investigated for the enriching of "suddite." It seems probable that the process will be successful. If so, it will mean that one ton of "enriched suddite" will do the work of three tons of coal, and this at an extra cost of a few shillings a ton in the manufacture. "Suddite" could then be exported to Port Sudan and used for all the coaling on the Red Sea.

ELECTRIC LIGHTING OF RAILWAY TRAINS: THE BRAKE-VEHICLE METHOD.*

By ROGER T. SMITH, B.Sc., Assoc.M.Inst.C.E.

The method of train-lighting considered is that in partial use on the Great Western Railway, where axle-driven dynamos and batteries controlled by an automatic regulator are installed on brake-vehicles only. The lamps throughout the train are supplied from these equipments, which work in parallel with each other, the brake-vehicle equipments and the lamp-wiring in the coaches dependent on them being connected electrically by through wiring coupled between coaches. There is consequently an appreciable reduction in initial cost and upkeep of plant, and, what is of chief importance from the railway point of view, increased reliability. Mr. William Langdon's paper, read before the Institution of Civil Engineers in 1891, describes his, the first, attempt to light electrically passenger rolling-stock in general, in place of lighting set or block trains which were never broken up in traffic. Mr. Langdon's final method provided one axle-driven dynamo in the block part of a main-line train, and a battery on each of the other coaches. All coaches

* Abstract of a paper read by Roger T. Smith, B.Sc., Assoc.M.Inst.C.E., at the Institution of Civil Engineers.

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were electrically coupled, and when uncoupled the lighting of each coach was continued during its branch journey by means of the charged battery. For any method of electric train-lighting applicable to all passenger rolling-stock the alternatives are either some such method as proposed by Mr. Langdon, or that every coach is "self-lit," that is to say, provided with it own axle-driven generator and battery. Other methods are either not applicable to passenger stock as a whole, or unsuitable for English railways.

The first aim of any method of train-lighting should be to light passenger rolling-stock adequately and with reliability. Measurement and experience lead to the provision of an illumination, measured on a horizontal plane at eye-level, of 2 foot-candles in 3rd class, and $2\frac{1}{2}$ foot-candles in 1st class compartments. Glare or dazzle can be minimised, if not entirely prevented, by keeping lamps out of the line of sight, by providing a white background behind the glowing filament, or by reducing the intrinsic brilliancy of the filament by enclosing the lamp in a diffusing globe or Holophane globe, the latter at the same time improving distribution. The tungsten train-lighting glow-lamp now replaces the carbon glow-lamp, its most economical efficiency with present train-lighting lamps being 1·3 watt per candle. On the average, tungsten glow-lamps, with a useful life of 850 hours, now have to be changed only once a year in the electrically-lit coaches on the Great Western Railway, where lamp-voltage is regulated within $\pm 2\frac{1}{2}$ per cent.

Any axle-driven system must in the first place provide a lead cell or other accumulator, so that the lamps are lit whether the train is standing or moving throughout its range of speed. In order to draw proper attention to the importance of the accumulator in train-lighting, it is both convenient and useful to look upon the accumulator as the essential element and on the dynamo as a device for making the output of the accumulator continuous throughout the hours of lighting. As typifying the accumulator the lead cell alone is considered. The two extremes among methods of charging lead cells are charging at constant voltage and charging at constant current, but a method of charging which combines the advantages of both extremes, while avoiding their disadvantages, is recommended, the charge being completely under the control of an automatic regulator set to give the proper compromise. The arrangement consists in starting with a heavy charge and gradually reducing it until, after proper gasing has taken place so as to mix the electrolyte, the charge is stopped when the cells are full, or the battery is left floating on the load while lights are on. Automatic regulation is necessary to secure a long and healthy life for the lead cell, and to reduce maintenance it is essential; when properly arranged, 10 per cent. per annum of the initial cost of the whole cell will provide for both maintenance and renewals of the plates and boxes.

The train-lighting dynamo is of secondary interest as compared with the battery, the essential element being some means of keeping the voltage constant at all speeds while permitting of its automatic variation by the regulator when required. The suspension and driving of the dynamo and the reduction of belt losses and renewals are among the chief factors in success. The automatic cut-in cut-out switch for connecting or disconnecting the dynamo from the battery should be actuated electrically, since the voltage of the latter may vary 25 per cent. from that of the former at any given speed. It is desirable that this switch should also act as an instantaneous automatic reverse-current circuit-breaker. The problem of automatic regulation has not attracted the British inventor as compared with other inventors on both sides of the Atlantic. The functions of an ideal regulator, combining in one or two instruments battery and lamp-voltage regulation, may be defined briefly as the following: First, it must control the lamp-voltage within $\pm 2\frac{1}{2}$ per cent. of the rated voltage of the lamps, and, within reasonable limits, must do so independently of lamp-load and entirely independently of battery-voltage. Secondly, when lamps are off, the regulator must control the generator-field so as to provide the full output of the dynamo for charging an empty battery; and when lamps are on, the balance of the full output must be available for charging. As charging proceeds the regulator must control the inherent regulation of the dynamo so that its voltage only rises sufficiently to give a diminishing charging current. Thirdly, with a fully-charged battery and lamps off, the regulator should reduce the charging current to zero. Fourthly, with a fully-charged battery and lamps on, the dynamo output must be adjusted to equal the lamp-load, leaving the battery in a floating condition with current neither entering nor leaving it. The foregoing requirements can to-day be obtained combined in one piece of apparatus.

To reduce the initial cost of electric train-lighting it is of first importance to reduce the number of battery cells, since within train-lighting limits it is the number of cells to be maintained, and not their size, which counts. The number of dynamos and regulators may be reduced in the same proportion. With the exception of through coaches transferred from main to branch lines, every train on the Great Western Railway has at least one brake-vehicle controlling it for traffic purposes, and all coaches which leave or join a main-line train *en route* are either brake-vehicles themselves, if detached or attached as single vehicles, or, if two or more coaches are detached or attached, they are controlled by a brake-vehicle. If every brake-vehicle is equipped with a generator and battery, the remaining coaches being wired only, while through wiring and couplers, designed to connect all vehicles together electrically, are provided on every coach, a less costly method of lighting trains is assured, as compared with the

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equipment of every coach as a self-lit vehicle. In addition, much greater reliability is secured by working two or more dynamos and batteries in parallel. This arrangement of equipment it is proposed to call the "brake-vehicle" method, because under ideal circumstances only brake-vehicles need be equipped. On the assumption that all Great Western passenger rolling-stock might be equipped for electric train-lighting, the percentage of brake-vehicles would be 27, of dependent coaches 40, and of self-lit coaches 33 for main-line working, while for local and suburban traffic the percentage of brake-vehicles would be 39 and of dependent coaches 61. If the ratio of brake-vehicles to dependent coaches were as one to three, and there were no self-lit coaches, the initial cost of equipping an entire rolling-stock of some thousands of coaches would be reduced by about 35 per cent. as compared with self-lit equipments, and the working costs would be reduced about 40 per cent. The increased reliability due to a higher percentage of generator coaches is, however, of greater importance to the railway than reduction in cost. In addition to the electrical requirements already specified for the ideal equipment, others are specially needed for the brake-vehicle method. It is of primary importance that the dynamo should be capable of running with its brushes short-circuited, while in addition its output must be capable of being quickly altered by a simple adjustment to suit altered traffic conditions.

An experimental six-coach train lit on this method was run nearly continuously for two years in all sorts of traffic, varying from fast main-line services to slow, stopping, local services. Two brake-vehicles, equipped with 45-ampere dynamos, regulators, and 180-ampere batteries, light themselves and three dependents. A self-lit detachable coach completes the train. The Leitner system provided the only available apparatus able to meet the special conditions. All the equipments are in parallel, coupled through cables throughout the train providing for this. For the lighting circuits the through wiring and method of coupling is arranged on the loop-positive system, one regulator controlling the lamp-voltage on each side of the loop. The same looped-positive brake-vehicle method has been applied to two trains running on South Wales services, to two new trains specially built for the Cunard boat-service between Paddington and Fishguard, and to two new trains used for Birmingham local services; and it is being further applied. The bus-bar system of through wiring, a simplification of the looped-positive system, is now being adopted. By the bus-bar system greater simplicity and increased reliability are secured as compared with the looped system, but at greater cost.

The total annual cost of lighting a six-coach train on the looped-positive brake-vehicle method is as follows. The cost of the initial equipment would be £761, inclusive of all carriage-work charges; adding working costs, extra cost of locomotive-power—determined experimentally—and capital charges, the total annual cost becomes:—

	£
Working costs	45
Power to drive dynamos, 1½ per cent. on £875	13
Haulage of extra weight, 1·7 per cent. on £875	15
Interest on £761 at 4 per cent.	30
Reproduction of capital in 20 years at 3 per cent.	23
Total annual cost of lighting a six-coach train	£126

With regard to the safety of electric train-lighting, although at 22 volts an arc can be formed between any of the metals employed in train-lighting, this arc will not persist. Provided the ordinary precautions necessary with electric circuits are taken, and suitable fuses are used and properly maintained, it is believed that complete immunity from fire risks can be ensured.

HOME INDUSTRIES.

Employers and the Insurance Act.—The Employers' Parliamentary Association is the outcome of a meeting of employers held in Manchester, at which it was unanimously resolved to form the Association. In the opinion of the founders of the Association, the trend of legislation makes it imperative that employers of labour shall be able collectively to take action with regard to any legislation which directly affects industry and commerce, business men having a right to be consulted on all such legislation. The immediate work of the Association will be to carry on the opposition to the National Insurance Act, and by all legitimate means to delay the application of the measure until its provisions are made acceptable to employers and workpeople. There is no intention to interfere with any of the existing Parliamentary associations; rather, it is hoped that all will co-operate, so that united action may be taken by every branch of trade and industry in the United Kingdom. All the great industries are interdependent, and united action is therefore essential. The Association will take measures to enlighten workpeople as to the effect of the Act, and will, wherever possible, ascertain their views by ballot. It will consider the regulations to be issued by the Commissioners; oppose or obtain modifications of regulations which are considered inequitable, and those likely to produce friction between employers and workpeople, and suggest amendments to the regulations by deputation to the Commissioners or otherwise. It will set up machinery by which the opinion of employers of labour will be obtained on any present or prospective legislation affecting industry and commerce. It is believed that the Association will be of much service, particularly to the many thousands of employers who do not belong to any Parliamentary organisation, since it

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will provide the opportunity for combination. The committee strongly urges on small traders the importance of becoming members of the Association, as they will in many cases be severely affected. The chairman of the provisional committee is Sir C. Macara, and the secretary (*pro tem.*) Mr. George Moores, who will be happy to give further particulars to any one who may write to him at 14, Cross Street, Manchester.

The Export and Home Trade in Cotton Goods.—As bearing upon the effect of the Insurance Act on the Lancashire cotton trade, it has been pointed out that a greater proportion of the British cotton trade is an export trade than in the case of any of its foreign competitors, and a correspondent of the *Manchester Guardian* has made a comparison of the position of the United Kingdom, France and Germany in this report. "If," he writes, "we represent the estimated number of spinning spindles (as given in the International Federation report) and the value of the exports of yarn and manufactures of the United Kingdom as 100, and calculate the similar figures for France and Germany as a proportion of this, we get the following comparison :—

	Spindles (in thous'ds).	Percentage of U.K.	Exports (1909) in £1,000.	P'centage of U.K.
U. Kingdom	54,522	100	93,444	100
Germany	10,480	19	18,222	19
France	7,300	13	13,658	14

Germany has 19 per cent. of the number of British spindles, and exports 19 per cent. of the value exported by Great Britain. France has 13 per cent. of the number of British spindles, and her exports amount to 14 per cent. of the British exports. This remarkable similarity of the proportions shows that in both Germany and France the proportion of exports to the total trade is roughly the same as in the case of Great Britain, unless the assumption can be maintained that the value of the output per spindle in Germany and France is much greater than in the United Kingdom. The consumption of raw cotton per spindle is definitely known to be much greater in the two foreign countries, but this does not affect the comparison. An additional inference of great importance may be drawn from these figures. The proportion of the British home trade to the total trade is usually placed at 20 per cent. If the same proportion applies in the case of the other two countries, it follows that Germany is clothing a population of 65 millions with one-fifth of the product of 10,480,000 spindles, France is clothing a population of 38 millions with one-fifth of the product of 7,300,000 spindles, while the United Kingdom is clothing a population of 45 millions with one-fifth of the product of 54,500,000. This throws an illuminating sidelight on the comparative purchasing powers of the three nations, nor is any difference in the yardage output per spindle or in the value of imports or in the use of wool, linen, etc., likely to make much difference to the comparison." These inferences must, however, be accepted with some reserve, since, as the *Manchester Guardian* points out, the piece goods exported by the United Kingdom are, in the main, of a much cheaper kind than those retained for home consumption, and also, it may be assumed, of a cheaper kind than those exported by France and Germany, which are more akin to their home trade goods. The difference in relative values would vitiate the calculation as to the proportion of the spindles employed for home trade and for export in the several countries.

Shipbuilding on the Thames.—The Government have intimated that they are prepared, upon certain conditions, to give a contract for the building of two protected cruisers, together with the engines, on the Thames forthwith, and to promise for next year the placing of two destroyers. The work is, of course, to be done at the Thames Ironworks, and the contracts are a concession to the East-end demand for a share of the shipbuilding work that has to be placed by the Admiralty. But it is by no means certain that the conditions insisted upon by the Admiralty will be accepted. These conditions are—that the work should be given to a northern company, and the company will not undertake the contract unless the men agree to work the same hours as are worked by men in the north; that is to say, fifty-three hours instead of the forty-eight that has ruled on the Thames for some time past. It is by no means certain that the men will agree to this return to a nine-hours' day. Moreover, exception is taken to the action of the Government in giving the contract to a northern company, understood to be the Palmer Shipbuilding Company, of Jarrow, without any consultation with the parties most directly concerned, namely, the Receiver of the Thames Ironworks and the interests he represents. Without expressing any opinion upon these knotty points, it may be hoped that the outcome of the negotiations will be the re-establishment of the Thames Ironworks and orders for the construction of men-of-war. It is of very great moment to the immense industrial district surrounding the works that they should be fully employed, and it is not less desirable, from the national point of view, that there should be works in the Thames where, in the event of a naval war, "lame ducks" may be taken for repairs.

The Telephone Transfer.—On Sunday last, at midnight, the Telephone Company ceased to exist, and 600,000 telephones passed under the dominion of the Post Office. The agreement, settled and signed in February, 1905, involves the transfer of £16,000,000 of capital and 18,000 employees. 1,253,890 miles of telephone wire are taken over by the State, and the capital value of the system has been estimated at £25,000,000. It may be remembered that the original licence of the National Telephone Company was for thirty-one years from

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January, 1880, but the Company was granted no monopoly. The 10 per cent. royalty last year produced £350,000. Opinions differ considerably as to whether the transfer will give the public a better service. Many fear the contrary. There is a general impression that England is much behind other European countries in the use of the telephone—but that is a mistake. The only European country which can be compared with the United Kingdom in telephone development is Germany, but, of course, the development of telephony in the United States of America is much greater than anywhere else, and England has done less for the country districts than some other countries.

"*Back to the Land.*"—Mr. B. Seebohm Rowntree and Mr. Bruno Lasker have just published a very valuable treatise on unemployment (Macmillan, 5*s*. net). It is a work that should be closely studied by social students and politicians of all persuasions, but the object in referring to it here is to direct attention more particularly to Chapter 8, "A Valuable Suggestion from Belgium." Briefly, the suggestion is that the town worker should live in the country and cultivate a plot of land. This would give the worker a second string to his bow, of incalculable value when work fell off in the towns, and his children, being brought up in the village, would often settle there. The writers believe that a scheme enabling men to reside in the country, while working in the towns, would operate with steady and accumulative effect in lessening unemployment and the dire evils which now attend it, and that it would not retard, but tend to further extensive economic changes making for greater stability of employment. The system works excellently in Belgium, where, although only 23 per cent. of workers are engaged in agriculture, 56½ per cent. of the population are living in the country. It has been rendered possible in Belgium by the interaction of three essential economic conditions—(1) the possibility of obtaining without difficulty land in small plots, and in the desired localities; (2) the provision of cheap and rapid transit between town and country; (3) the provision upon easy terms of capital for the erection of houses. The plots vary in size from a small vegetable garden to one or two acres, or even more. The produce from the plot is not, as a rule, sold, but kept for home consumption. As Mr. Rowntree puts it, a family with a substantial garden—a quarter of an acre, for instance—may have to live hardly when no wages are coming in, but if there is a supply of potatoes and green vegetables, with possibly bran, and milk from a goat, they do not starve. These things just furnish the little reserve of wealth which tides over the difficulties. Plasterers, bricklayers, and other similar workmen, often do not trouble to look for work in towns when it is scarce. Even some of the Antwerp dockers, if they learn on arrival at the docks that very few ships are coming in, return home instead of swelling the army, already far too large, of men scrambling for the few vacancies that occur. Is a similar system practicable in England? It must be remembered that there is no country in Europe where land is so much subdivided as in Belgium, or where transit facilities are so good. Every tenth inhabitant, and every fifth adult, is a landowner, and the accumulation of land in a few hands is rendered impossible by the laws of succession. Then a ticket, enabling a workman to travel three miles to and fro for six consecutive days, costs 9*d*., or ¼*d*. a mile. If the distance to be travelled daily each way is 6¼ miles, the ticket costs 1*s*., or ⅛*d*. per mile. For 12½ miles each way it costs 1*s*. 2½*d*. a week, or $\frac{1}{10}$*d*. per mile. For 25 miles each way it costs 1*s*. 7*d*., or $\frac{1}{15}$*d*. per mile. The difficulties in the way of such cheap transit in England are obvious, but not necessarily insuperable, and there is plenty of suitable land that could be got, at from £70 to £80 downwards, whilst the necessary capital for laying out and developing the land and putting up buildings might be obtained by county councils exercising the powers given by the Small Holdings and Allotments Act, 1908, the money being borrowed from the Central Government at 3½ per cent. It is much to be wished that some one county council would make the experiment. Its results might well be more beneficial than those accruing from some of the more ambitious schemes which find favour in high quarters.

CORRESPONDENCE.

THE FISHERIES OF BENGAL.

In seconding a vote of thanks to Dr. Travis Jenkins for his paper on "The Fisheries of Bengal," my father, Sir George Birdwood, expressed the wish that I, when invited by the Chairman to speak, had done so. My reason for asking to be excused was a business one. It is to the commercial and financial side of the question that I have confined my attention. In the course of certain interpolations of an altogether delightful character, Dr. Jenkins introduced matter which seemed to modify preconceived opinions, and it was essential carefully to consider how his remarks affected the financial interests concerned.

When the question of forming an English company to develop the Indian sea fisheries was first mooted, the matter which principally appealed to those interested was the question of food supply for the inhabitants of India. The first inquiries, therefore, which had to be made were: are there edible fish in the Bay of Bengal, can those fish be caught, and can the catch be marketed? The evidence, which consisted of Dr. Alcock's report and certain practical details furnished by Captain Row from actual experience, clearly indicated that the supply of good fish is unlimited, that the fish harvest is perennial, that fish is a necessity to a rice-eating population, and that the demand for fish throughout India is practically unlimited, caste

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prejudice affecting the question only to a small extent. Accordingly, the two main factors of success in any commercial undertaking, unlimited supply and unlimited demand, appeared to be present to a peculiar degree in the project.

The next question was the attitude of Government. It had always been understood that the Government of India were particularly desirous that these deep sea fisheries, and especially those of the Bay of Bengal, should be developed. Lord George Hamilton, when Secretary of State for India, had dealt with the salt tax on cured fish, and more recently Government had given practical proof of their desires by the appointment of Sir Krishna Gupta to inquire and report, and by the chartering of the "Golden Crown." I have had access to the correspondence passing between certain gentlemen in England and the Government of Bengal, and also the report of interviews in Calcutta with the Government representatives and the representatives of the English group. The outcome was that Government stated they were prepared to give the following assistance:—

(1) The grant of a rebate of the salt duty.
(2) The grant of lands for depots on the coast line wherever Government land was available.
(3) Their influence to induce the Port Commissioner to allot suitable quays at Calcutta or elsewhere.

In addition to the above, Government had been asked to aid the proposed enterprise, either by guaranteeing a dividend on the capital employed, or by guaranteeing a monopoly of the rebate of the salt duty for a period of years. In their memorandum to Government, the organisers of the enterprise had pointed out that a considerable amount of money would be risked in proving the industry on a commercial basis, and they went on to say:—"If our efforts are successful, we shall be prejudiced to the extent of this sum of money in favour of any competitors who may, utilising the knowledge which we have acquired, then enter the field against us; and we feel that we may fairly ask some privilege in return for this tentative initial outlay of capital." The request was refused; the matter is still deadlocked, and, in my humble opinion, for the following reason. India does not afford scope for individual private enterprise. If a pioneer of the type of Cecil Rhodes, having genius, courage, and cash, were looking round to-day for new openings, he would, I fear, turn his eyes away from India. India, so far as new local industries are concerned, has still to lean on local capital, and, so far as the Bengal fisheries are concerned, local capital does not appear to be very red hot. As a fact, a good many years ago, before the methods of steam trawling had reached the almost scientific perfection of to-day, certain individuals in India invested a little capital in a steam trawler with the idea of proving the fishing grounds; the money was lost, and the loss, perhaps, still galls. Now, in the absence of local capital in India, or private capital at home, the appeal has to be made to the public. That is done either by direct advertisement, which means several thousands of pounds at speculative risk, or by underwriting. Underwriters do not take "firm," they only guarantee that they will subscribe if the public does not. In the case of the Indian fisheries, underwriting cannot be done, because the underwriter, though he recognises the vast potentialities of the scheme, is of opinion that the public will not invest unless the dream has some substantial basis of Government support. If it were a tea garden, or a jute or cotton mill, or a gold mine, underwriting could, doubtless, be done, for the British public in those particular matters is more or less educated in Indian commercial affairs. But when a company proposes to work an Indian product for Indian consumption; when the earnings and profits are hypothetical, and are only based on what has been done under totally different circumstances in other parts of the world, I, for one, would not care to guarantee the chance of the British public coming in, unless the scheme were strengthened by some measure of Government support.

I do not suggest, or believe, that the present condition of affairs will endure. During Lord Curzon's Viceroyalty a most wholesome impetus was given to the introduction of British capital into India. For various reasons, local and otherwise, that stream of capital was headed off. Recent events may once more cause it to flow Indiawards; and, in that event, I feel confident that the underwriting difficulties will disappear, for, as I have said, these arise out of ignorant public apathy. With regard to the scheme generally I will not go into the question of estimates. Dr. Jenkins, so far as modern methods are concerned, confined his observations to the estuarine fisheries of the Bay of Bengal, claiming that without modern appliances, and simply by methodical management under European control, the existing native catch would be sufficient for Calcutta purposes. Dr. Jenkins, in fact, advocated the use of improved methods for the supply of fresh fish for Calcutta alone. But my view is not confined to Calcutta and its environments, or even to Bengal. As an initial business proposition, doubtless the supply of fresh fish for Calcutta organised in the manner suggested by Dr. Jenkins affords the best inducement for immediate investment, but such an organisation would not interest, for it would not require English financial support. But in my opinion it is the catering for the multitudes that is the key to the position; and that can only be done by cured fish. It is by means of cured fish that nutritious food could be brought within reach of the very poorest throughout the Peninsula; and I feel very confident that it is only by adequately developing the deep sea fisheries of the Bay of Bengal by means of modern sea trawlers that fish can be caught in sufficient quantities to supply the inland districts of India. Founding my judgment on the opinion of those who are well acquainted both with the local conditions and with all the ramifications of the trawling trade, I long ago came to the

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conclusion that the scheme to develop this industry in Indian waters is one which has good prospects of great success. The finding of the fish, the catching of the fish, the delivery of the fish fresh in Calcutta, and the sale of the fish at a commercial profit, all appear to be capable of achievement, given sufficient capital and efficient management.

FRANK BIRDWOOD.

OBITUARY.

ISAAC JULIUS WEINBERG.—Mr. Isaac Julius Weinberg died at Brighton on the 1st inst., in his eightieth year. A German by birth, he was a member of the well-known jute firm of Messrs. Moore and Weinberg, of Belfast and Dundee. He was a man of great energy and ability, and did business in practically every part of the world. He played a prominent part in the negotiations which led to the French Commercial Treaty. He took a deep interest in education, and was a governor of University College, Dundee. He was a member of the Royal Society of Arts for just over half a century, having been elected in 1861.

NOTES ON BOOKS.

WHERE GREAT MEN LIVED IN LONDON. London: A. & C. Black. 1*s*. 6*d*. net.

The idea of this little book is good. It certainly gives pleasure and interest to many people to know the houses in which famous men have lived. As is well known, the work of marking such houses with memorial tablets was initiated by the Royal Society of Arts, and is now carried on with admirable care by the London County Council. The work is progressing but slowly; but any one who reads the pamphlets published from time to time by the Council will realise how extremely difficult it is in many cases to identify an old house beyond a doubt. Streets may be renumbered, houses may be pulled down; two may be made into one, or one into two—in short, in neighbourhoods of any antiquity where the builders have been active, the most minute and painstaking research is often necessary before one can state, with confidence, that this is the house in which So-and-so lived. In illustration of this, Lord Rosebery, in unveiling the tablet to the memory of Lord Macaulay at Campden Hill—the first, by the way, ever set up by the County Council—told an amusing story. "I myself," he said, "have been in the habit of sometimes trying to find the houses of distinguished men without the guidance of a memorial tablet. I used to be greatly gratified by the reflection that the second Pitt had lived in Berkeley Square at the time of the formation of his first Government, and, having got the number, I was accustomed to show my friends who were walking with me, when conversation flagged, the house of the younger Pitt. It was something of a blow to me to be assured by the historian of Berkeley Square, who had given great attention to the matter, that the numbers had all been changed, and to find that I had been lavishing an immense degree of unnecessary sympathy, and had been creating a vast amount of spurious sentiment, on a house which had no more to do with Mr. Pitt than it had to do with Lord Macaulay."

The cynic may assert that, when gazing at the wrong house, Lord Rosebery enjoyed just as fine a thrill as when he afterwards found the right one; but most persons will agree that of this particular branch of study, exactness is the very essence. And this is the quality in which the little volume under notice appears to be somewhat deficient. For instance, if one looks under the heading "Stoke Newington," one finds eleven entries, but of these only four are given any more particular address; and it would certainly require a more than ordinary power of appreciating associations to enable a man to gaze with interest at that lugubrious district, because it was the home of Dr. Aikin, Mrs. Barbauld, and various other ladies and gentlemen.

AN ANALYSIS OF THE CHURCH OF ST. MARY, CHOLSEY, IN THE COUNTY OF BERKSHIRE. By F. J. Cole, D.Sc. (Oxon.), Professor of Zoology, University College, Reading. Oxford: B. H. Blackwell. 5*s*. net.

An interesting scheme has been initiated by the authorities of University College, Reading. The town and its neighbourhood abound in subjects for historical research, and in order "to stimulate public interest in the history of the locality, and to afford a means by which the general historical teaching at University College may gradually become connected with, and be illustrated by, the detailed evidence which is furnished by local history," a fund has been started to defray the cost of the publication of studies dealing with particular aspects of this history. This is the third volume of the series, the first being "The Town of Reading during the early part of the Nineteenth Century," by W. M. Childs, M.A., Principal of University College, Reading (who is general editor of the series), and the second "The Place Names of Berkshire," by F. M. Stenton, M.A., Research Fellow in Local History, University College, Reading.

The Church of St. Mary, Cholsey, has a twofold interest—its ancient foundation and its intrinsic beauties. If there is no actual Saxon building still extant, the church certainly stands on the site of a Saxon monastery, and the ground plan indicates that it was once a very considerable ecclesiastical centre. Professor Cole gives a minute and careful description of the building, illustrating it with drawings of mouldings, plans, and some excellent photographs. The volume is a model of what such a monograph should be.

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THE ELEMENTS OF PERSPECTIVE. By Aaron Penley. Revised and partly rewritten by A. P. Killik and D. B. Hedderwick. London: Winsor and Newton. 1*s*. net.

It is scarcely necessary to call attention to the merits of this well-known little handbook. It has now reached its forty-seventh thousand, and is in general use in schools and colleges where art is studied at all seriously. The present edition has been, to a large extent, rewritten, and both the text and illustrations have been considerably simplified. It is now very succinct and clear, and in little over sixty pages it takes the student from the drawing of a simple cube to the perspective of a cruciform church.

GENERAL NOTES.

NIGHT SIGNALS FOR AVIATION.—The use of illuminated captive balloons for the purpose of guiding aeronauts and aviators on their way by night is being tried in Germany. One of these has lately been placed at Treplow (between Berlin and Stettin). The balloon, which is 2½ metres (about 8 feet) in diameter, is of a red colour, and carries an electric light. It is visible for a great distance at night, and is easily distinguished from any other light. In case of fog, when the light could not be seen, an electric bell is caused to ring by means of a hygrometer attached. In this way it is possible for a person in charge to ascertain the height of the fog zone, and cause the balloon to ascend into a less moist and clearer atmosphere, when the bell will cease ringing.

MEMORIAL TABLETS.—A memorial tablet has been affixed to No. 22, Hereford Square, Brompton, the house in which George Borrow lived from 1860 to 1874. He had before this time reached the height of his fame, and during the period of his residence in London his literary output was not considerable. A tablet has also been affixed to No. 13, Johnson Street, Somers Town, where Charles Dickens spent a part of his boyhood. Two other houses, No. 48, Doughty Street and No. 1, Devonshire Terrace, had previously been indicated by the London County Council as the novelist's residences at later periods of his career. A further tablet has recently been affixed to No. 17, Red Lion Square, W.C., which was for a short time the home of that remarkable triumvirate, Dante Gabrielle Rosetti, William Morris, and Edward Burne-Jones.

THE PRODUCTION OF FIBRE FROM NETTLES IN AUSTRIA.—The spinning department of the Kaiser Franz Josef School of Textile Industry, in Reichenberg, is now experimenting with the cleaned fibre of the nettle. By the new Austrian process, the gum is extracted from the fibre of the plant by mechanical, and partly by chemical means. The stalks are relieved of their wood, resin, and rubber substances by pressure. The experiment station at Brunn has succeeded in completely separating and spinning the fibres furnished without destroying their tension or firmness. These experiments were made on knitting yarn machines, and yarns were produced which it is claimed, owing to their excellent qualities, can be used in various branches of weaving and knitting, in the production of furniture covers, blankets, tapestries, damasks, cloths, ribbons, laces and underwear. The inventors of the new process believe that, sooner or later, nettle fibre will largely replace cotton, and that by the same process spinning fibre can be obtained from the stalks of hops and other plants.

THE OUTPUT OF BRITISH COAL IN 1910.—The annual report by the Chief Inspector of Mines on the output of mines and quarries for 1910 (Cd. 5977) contains, as usual, some interesting statistics. The total value of the minerals raised in the United Kingdom during the year was £122,105,582, an increase of £2,728,643 over the total for 1909. This difference is mainly accounted for by the rise in the value of coal. The total output of coal was 264,433,028 tons, and the value £108,377,567—increases of 658,716 tons and of £2,102,667 respectively on the figures for 1909. The average price of coal was 8*s*. 2·36*d*. per ton in 1910 as compared with 8*s*. 0·7*d*. in 1909. Continental countries purchased less British coal in 1910 than in the previous year, and the quantity of coal exported (exclusive of coke, manufactured fuel, and coal shipped for the use of steamers engaged in foreign trade) was almost a million tons less than that for 1909, viz., 62,085,746 tons. The decrease would have been greater but for the fact that more coal was exported to South America than in the previous year. France received over 9½ million tons, Germany over 9 million tons, Italy over 8¾ million tons, Sweden nearly 4 million tons, Russia nearly 3¼ million tons, Egypt, Spain, the Argentine and Denmark each over 2½ million tons, and the Netherlands nearly 2½ million tons. Adding the 2,930,467 tons exported in the form of coke and manufactured fuel, and the 19,525,735 tons shipped for the use of British and foreign steamers engaged in foreign trade, we find the total quantity of coal which left the country in 1910 was 84,541,678 tons, as against 86,037,006 tons in 1909.

SIAMESE ELEPHANTS AND IVORY.—Roughly estimated, the number of domesticated elephants in Siam is about three thousand. The supply has been decreasing yearly and prices have advanced, until now a full-grown male elephant is worth about £500 and a female £350, according to the American Vice-Consul at Bangkok. Travel in northern Siam, especially during the rainy season, would be impossible without the elephant, and he is used to great advantage in the teak wood industry. An elephant is full grown at twenty-five years, but not in full vigour until thirty-five. The length of life is eighty to one hundred and fifty years, and the average weight is about three tons. In Siam the elephant carries only two hundred and fifty to five hundred and fifty pounds according to the size of the

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animal. No estimate can be made of the number of wild elephants in the jungles of Siam, but in one of the elephant drives in the Ayuthia district recently, more than two hundred were seen at one time. Permission to capture wild elephants may be obtained from the Siamese Government, and for each animal caught a royalty of £30 is paid, but such capture is exceedingly difficult and expensive. The export of ivory in the fiscal year ended March 31, 1910, amounted to 4,301 pounds, and that is a fair average of the export for the past five years.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 17.—Cyril Davenport, F.S.A., "Illuminated MSS." Sir Walter Armstrong will preside.

January 24.—William J. Gee, "Hydraulic Separating and Grading."

January 31.—Professor G. W. Osborn Howe, "Recent Progress in Radio-Telegraphy." Sir William H. White, K.C.B., F.R.S., will preside.

February 7.—Leonard Hill, M.B., F.R.S., and Martin Flack, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

February 14.—Cecil Thomas, "Gem Engraving." Sir Arthur John Evans, D.Litt., LL.D., F.R.S., will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 18.—The Rev. Walter K. Firminger, B.D., Senior Chaplain, Bengal Establishment, "The Old District Records of Bengal." Sir James A. Bourdillon, K.C.S.I., will preside.

February 8.—Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India."

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

April 25.—Walter Saise, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 30.—W. A. Legg, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony, "Irrigation in South Africa." The Hon. Sir Richard Solomon, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, will preside.

March 26.—R. H. Barraut, Resident at Jesselton, "British North Borneo."

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Vaughan Cornish, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." Two Lectures.

Syllabus.

Lecture I.—January 22.—The size and speed of ocean waves—The height of waves in lakes, seas, and rivers—The length of waves in lakes, seas, and rivers—The steepness of waves, and strains upon ships—The periodic time of waves, and the rolling of ships—The speed of waves and its relation to velocity of wind—The height of waves and its relation to velocity of wind—The time required to develop large waves, and the duration of storms—The length and speed of the swell observed after storms—The probable height of the swell during storms—The relation between the dimensions and path of a cyclonic depression and the nature of the winds produced—The depth in which waves break, and its relation to defence works.

Lecture II.—January 29.—The action of waves and tidal currents on sea-beaches and sandbanks—The proper action of waves to drive sand and shingle shoreward—The proper action of waves to drive mud seaward—Special conditions under which the action on sand is reversed—The proper action of the tide to drive shingle in the direction of the flood—The normal removal of shingle from promontories and its accumulation in bays—The exceptional accumulation of shingle in salient positions, *e.g.*, at Dungeness—Groynes—The reason of the graded arrangement of shingle on the Chesil beach—The formation of a sandbank on the up-channel side of a promontory—Sandbanks in estuaries and their arrangement by tidal currents—Their rippled surface as a means of mapping these currents—Their influence on the formation of tidal bores—The struggle between land water and tidal water to arrange the sandbanks in the Severn—The variability of the Severn Bore as determined by these factors—The circumstances which determine the starting point of the Severn Bore.

Loudon M. Douglas, F.R.S.E., "The Meat Industry." Three Lectures.

February 5, 12, 19.

Luther Hooper, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

Noel Heaton, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

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HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry." PRINCIPAL SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., will preside.

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

FRANK WARNER, "Silk."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 8...Post Office Electrical Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 5 p.m. Mr. A. J. Stubbs, "Precautions against Fire."

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Messrs. C. T. Kingzett and R. C. Woodcock, "The Production of Formic and Acetic Acids by the Atmospheric Oxidation of Turpentine." 2. Messrs. C. Davis and J. L. Foucar, "A Rapid Volumetric Method for the Determination of Free Sulphur." 3. Messrs. W. P. Dreaper and W. A. Davis, "The Relative Adsorption of Dyes by Sand and Natural Fibres." 4. Mr. W. P. Dreaper, "Ingrain Dyeing—Influence of Certain Groups on the Re-solution Factor."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Frank W. Hunt, "The Tendency of Recent Modifications of the Lands Clauses Act."

Geographical, Burlington-gardens, W., 3 p.m. (Juvenile Lecture.) Mr. W. H. Garrison, "Our World-Wide Empire."

Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Rev. Professor G. Milligan, "The Greek Papyri."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. L. Courtney, "Learned Greek Women: Sappho and Aspasia."

TUESDAY, JANUARY 9...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. D. G. Hogarth, "Carchemish."

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Dr. P. Chalmers Mitchell, "The Childhood of Animals." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. S. H. Ellis, "Reinforced-Concrete Wharves and Warehouses at Lower Pootung, Shanghai." 2. Mr. W. C. Popplewell, "The Direct Experimental Determination of the Stresses in the Steel and in the Concrete of Reinforced-Concrete Columns." 3. Mr. W. H. Burr, "Composite Columns of Concrete and Steel."

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. D. J. Smith, "The Repair of Motor Vehicles."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. The Earl of Dudley, "Some Impressions of Australia."

WEDNESDAY, JANUARY 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Juvenile Lecture.) Mr. C. Vernon Boys, "Soap Bubbles." (Lecture II.)

Geological, Burlington House, W., 8 p.m. Mr. S. Hazzledine Warren, "On a Late Glacial Stage in the Valley of the River Lea, subsequent to the Epoch of River-Drift Man."

THURSDAY, JANUARY 11...Cyclists' Touring Club, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.30 p.m. Mr. E. C. Russell, "A Modern Canterbury Pilgrimage."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Discussion on the Reports on "The Standardisation of Drawings for Reinforced-Concrete Work," and on the "Consistency of Concrete."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. C. E. Lowe, "Beethoven—the Man and his Music."

Automobile Engineers (Graduates' Section), 13, Queen Anne's-gate, S.W., 8 p.m. Mr. A. R. Pettit, "Balancing."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. W. Thomas, "Tramps with a Camera."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. C. A. Ablett, "Some General Principles involved in the Electric Driving of Rolling Mills."

Mathematical, 22, Albemarle-street, W., 5.30 p.m.

FRIDAY, JANUARY 12...Malacological Society, Burlington House, W., 8 p.m. 1. Mr. W. H. Dall, "Note on the Genus *Panope* Ménard." 2. Mr. A. J. Jukes-Browne, "Nomenclature of the *Veneridæ*; A Reply to Dr. W. H. Dall." 3. Mr. A. W. Stelfox, "The Occurrence of *Helicella heripensis* in Great Britain; Notes on Some British Non-Marine Mollusca." 4. Mr. G. K. Gude, "Characters of Two Undescribed Land Shells from Colombia; Explanation of the figures occurring in Westerlund's 'Sibirien's Land och Sottvatten Mollusker,' 1876; on two preoccupied specific names in *Gasteropoda*."

Astronomical, Burlington House, 5 p.m.

Medical Officers of Health, 1, Upper Montague-street, W.C., 5 p.m. Dr. William Butler, "The Exclusion of Infected Children from Schools."

British Foundrymen's Association (London Branch), Cannon-street Hotel, E.C., 8 p.m. Mr. H. C. W. Carpenter, "Growth of Cast-Iron."

SATURDAY, JANUARY 13...North-East Coast Institute of Engineers and Shipbuilders, Bolbec Hall, Newcastle-on-Tyne, 7.30 p.m. Mr. H. C. Stroud, "Wireless Telegraphy for Naval Purposes."

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Journal of the Royal Society of Arts.

No. 3,086. VOL. LX.

FRIDAY, JANUARY 12, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 17th, 8 p.m. (Ordinary Meeting.) CYRIL DAVENPORT, F.S.A., "Illuminated MSS." SIR WALTER ARMSTRONG will preside.

THURSDAY, JANUARY 18th, 4.30 p.m. (Indian Section.) The REV. WALTER K. FIRMINGER, B.D., Senior Chaplain, Bengal Establishment, "The Old District Records of Bengal." SIR JAMES A. BOURDILLON, K.C.S.I., will preside.

JUVENILE LECTURES.

On Wednesday afternoon, January 10th, Mr. CHARLES VERNON BOYS, F.R.S., delivered the second and final lecture of his course on "Soap Bubbles."

Frames of wire, said Mr. Boys, of various geometrical patterns, dipped in soap solution and taken out, were found to carry film patterns of exquisite beauty, but always so that three films met at equal angles in a line, or six in a point, and this was the essence of the structure of froth. Large bubbles joined together in groups of two to half-a-dozen showed the same features on a larger scale. Such multiple bubbles, or single large bubbles containing just enough gas to float and no more, were interesting when turned adrift out of doors, more especially in a town. The reflections of the sky-line from the large spherical surface, or of sunlight from the large plane coloured interfaces, were alike surprising and beautiful. "Dream" portraits might be photographed by reflection from spherical or hemispherical bubbles. In order to blow big bubbles it was best to make use of the injector principle, as so much air and so little pressure were needed. The bubbles blown with the two hands and mouth at the opening of the first lecture were blown in reality by an injector action at a speed far beyond that at which the lungs could supply the air. Even bellows were poor things by comparison. An injector, with a tangential inlet, worked by foot-bellows, was made use of, as also a small motor-driven fan intended for drying ladies' hair. With either of these, very large bubbles could be blown quickly, and a little gas being introduced at the same time, they were made to support themselves and float away.

The electrically-driven hair-drier was also used to make a vertical stream of cold air, which, if strong, would carry a soap bubble away to a great height, or keep a couple of ping-pong balls floating in the stream of air. When the speed of rotation was reduced by the use of a Ferranti lamp-dimmer in the electric circuit, soap bubbles, either alone or in rings, would remain balanced in the air stream like the ping-pong balls until they broke. On turning the three-way switch in the handle of the hair-drier so as to send the current into the heating coils, a stream of hot air, or warm air, could be made, and when bubbles were blown with this, being warm, they were lighter than air, and ascended like fire balloons; but, presently cooling, they came down again, when they could be arrested in their descent by the stream of air, and sometimes the lower half could be introverted into the upper half.

Experiments with bubbles, such as blowing out a candle with the issuing air, floating one on the vapour of ether, and burning the vapour issuing from a bubble lifted from the ether, were shown.

The increase of the tension of a soap film in the presence of ammonia was shown by placing a bubble in a ring and holding a wet stopper above it, when it immediately shrank away from the stopper and slipped through the ring, or by holding a wine-glass containing weak ammonia below, when it escaped again, as though annoyed by the smell. When the bubble was too big to go through the ring, the efforts

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were visible, and then a tear formed and hung from the bubble.

The series of experiments with bubbles one inside another, which are described in the new edition of the book on "Soap Bubbles"* by the lecturer, which the S.P.C.K. have brought out this week, were then shown, including those on the effect of electrification.

The short time remaining was devoted to experiments on the colours of soap films and celluloid films, winding up with Brewster's gorgeous experiment of a soap film made to spin by the impact of a jet of air (for which the hair-drier was again used). This gave rise to expanding eyes of colour of great brilliance.

On the motion of the Chairman, Lord Sanderson, G.C.B., K.C.M.G., a vote of thanks was accorded to the lecturer for his interesting course.

THE ROYAL SOCIETY OF ARTS.†

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

VI.—The Premiums.
(1754–1851.)

As previously mentioned, the sole original object of the Society was to promote art, industry, commerce, and invention, by granting rewards and premiums for meritorious discoveries and inventions, for success in the various branches of the fine arts, painting, and sculpture, for increasing the economic resources of the kingdom by the import of new or little known materials of industry, or for developing those resources by new or improved methods.

The Society took infinite pains to prepare a list of suitable objects for its premiums. Each year the list was carefully revised. Some items were omitted, either because the offered award had been made, or because it had elicited no response. Fresh items were constantly added, and changes made in the terms of those which were not dropped. And besides the specified articles in the list, the Society was ever ready to consider any suitable application, so that it constantly made grants for things entirely outside its own proposals, so long only as the object was deemed worthy.

At first only money prizes were proposed. These varied in amount, and were, in many cases, really grants-in-aid rather than complimentary prizes. After a while it was suggested that such prizes, when of a complimentary character, might take the form of medals, and in 1756 Henry Baker proposed that the Society should give "gold and silver medals as honorary premiums, with a view of exciting emulation among the nobility and other persons of condition, with whom pecuniary premiums could have no weight." The matter was referred to a committee, upon which sat Hogarth, Nicholas Highmore, James Stuart, Thomas Hollis, and William Chambers. The committee discussed the question before them for about two years, and at last decided upon a design by Stuart. The medal was made by Thomas Pingo, the famous die-sinker, and it remained the chief medal of the Society during the whole of the first period of its existence. Copies of the medal struck in gold were at once given to the President, Jacob Viscount Folkestone, and to Robert Lord Romney, Vice-President, both "for eminent services"; one also went to William Shipley "for his publick spirit, which gave rise to the Society," and another to James Stuart "for designing the honorary medal of the Society." Later, gold medals for services rendered to the Society were presented in a good many cases. A few years after this it was decided to give honorary rewards in the class of polite arts in the form of a silver palette, and the first award of this palette was in the year 1767.

The classes under which the awards were arranged varied from time to time, but eventually they were distributed among six committees:—

1. Polite arts.	4. Mechanics.
2. Agriculture.	5. Chemistry.
3. Manufactures.	6. Colonies and trade.

The subject-matter with which the different committees dealt is sufficiently indicated by their titles. "Polite arts" included painting, drawing, sculpture, die-sinking, designs for manufactures, and also, to a certain extent, literature. Agriculture included forestry. Mechanics and manufactures were at one time dealt with by one committee, but were afterwards divided. Chemistry was industrial chemistry only, but comprehended also other branches of applied science. Colonies and trade was practically restricted to colonial matters. Besides, there were at various times other Committees, such as those on Correspondence, on Miscellaneous Matters, etc.*

* See "Notes on Books," p. 231.

† The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, and November 3rd, 1911.

* "Agriculture" and "Colonies" have already been dealt with. "Polite Arts" will be treated separately. All the other subjects are included in the article, of which the first part now appears.

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At first a number of members were appointed on each of these committees. At a later period this practice was abandoned, two chairmen were elected at the annual meeting for each committee, and it was left to those members who thought fit to attend.

The practice seems to have been that a general notice was sent round to those who were in the habit of attending the committees, and also to other persons, who were not necessarily members of the Society, known to be interested in, or conversant with, the subjects which were to come before the meeting. The whole proceedings were conducted with a good deal of formality. Any communication which was received was referred by the Secretary to the committee to which it seemed appropriate—the committee consisting, as above shown, of a certain number of persons who might be considered as more or less experts, and of any members of the Society who liked to attend. The candidate for the premium was also invited to be present to give such an account of his invention as he thought proper. After he had given his own version, and had replied to any questions which were addressed to him, the subject was discussed, first in his presence, and then after his withdrawal. Formal resolutions were then put as to the award to be made, and this recommendation was submitted to the next ordinary Wednesday meeting of the Society, when it was generally confirmed, but in some cases disapproved. If any award was made, the paper was generally referred to the Committee on Papers, with a view to its being inserted in the next volume of *Transactions*, if suitable.

It is thus evident that a great deal of trouble was taken to ensure a fair adjudication of the premiums. But it must often have happened—and, indeed, from the records it is evident that it did, at all events, sometimes happen—that the committee were by no means competent to deal with the invention, especially if it was of a new and original character. The committee must also, in the nature of things, have generally been composed of amateurs, who, however well-meaning and hard-working they might be, were sometimes incapable, and, in all cases, naturally biased by their own opinions. On the whole, however, it may be said that no one who makes a careful investigation of the awards made—and probably there are not very many who would care to undertake such a task—can fail to be of opinion that a genuine effort was made to do justice, and that in a great majority of cases fair justice was done. As a matter of fact, it is quite certain that most of the awards leaned to the side of generosity. But while a great many undeserving inventions were rewarded, there are not a great many which were rejected and which afterwards proved themselves of any value.*

The first actual premium list issued was that of 1756, and this only exists in manuscript. The first printed list is the second issued, and that is dated 1758. From that date the lists were issued annually. Till the publication of the first volume of *Transactions*, in 1783, the lists were issued separately; from 1783 they were included in each volume of the *Transactions*, besides being printed separately. The Society's set of lists before 1782 is, unfortunately, not complete, a volume in which the lists from 1763 to 1767 inclusive were bound up, having apparently at some time been lost. A separate copy, however, of the list for 1764 has been preserved. A partial list for 1765 and the complete list for 1766 are printed in the *Museum Rusticum*.† The British Museum set is complete from 1758 to 1781 inclusive.

After 1829 many changes were introduced in the lists. The importance of the Society's prizes was much diminished, and the character of its work was changing. The lists were shortened. Sometimes the offers of prizes were in general terms instead of for specific objects. From 1843 to 1847 the list was only issued every other year. With the grant of the Charter in 1847 the Society's system of prize-giving practically came to an end. Special prizes were offered and awarded from time to time, but the practice of issuing a general list of subjects for awards, though it was not formally abandoned, was really obsolete. A sort of attempt to renew it was made in 1863,‡ when a list of the old character was published in the *Journal*. The last such list appeared in 1873, but no awards were made upon it, and in practice the whole system had been defunct for at least a quarter of a century.

The first lists of awards made by the Society are contained in Dossie's "Memoirs of Agriculture," in which they were published by the Society's authority. The list down to the end of 1767 (exclusive of "Polite Arts") is given in the first (1768) of Dossie's three volumes

* A full and detailed account of the method adopted in making the awards will be found in the address delivered by Arthur Aikin, at the distribution of awards by the Duke of Sussex, as President. in 1817.

† Vol. V. p. 90; Vol. VI. p. 339.

‡ *Journal*, Vol. XII. p. 9.

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(page 3). The complete list of the awards in "Polite Arts," to the end of 1776, and the other awards, from 1768 to 1776 inclusive, appear in his third (1782) volume (page 447).

The same list was also published by the Society in 1778,* and in a few cases where the two lists differ it may be assumed that the Society's list is accurate. There are very few discrepancies. There is yet another list, down to 1770, given in the "Description of the . . . Machines . . . in the Repertory of the Society, etc.," published by William Bailey, the Registrar of the Society in 1772.†

In the second volume of the *Transactions* (1784) a list is given of the awards from 1775 to 1782 inclusive. This list is by way of being a continuation of Dossie's lists, though, as a matter of fact, the two overlap as regards the years 1775 and 1776. From this date onwards the awards are given year by year in the annual volumes of the *Transactions*, down to what is really the last volume of the series, that for the session 1843–4, Vol. LV. In the interval between the cessation of the regular *Transactions* and the commencement of the *Journal*, lists for the years 1845 to 1850 were issued, and all of these are extant, that for 1847 being in MS. only. In 1851, the year of the Great Exhibition, there was no distribution of prizes, on account of the exhibition, and consequently no list. In 1853 there was a meeting for the distribution of prizes, and a list was printed in the *Journal*.‡

The premium lists were advertised and circulated as widely as possible. At one time the Society received a little official help in obtaining publicity for its work, for in 1775 the Postmaster-General sent a copy of the list to the local post offices, with instructions to the postmasters to let all persons coming to their offices have an opportunity of reading it.

An examination of the old prize lists, especially those between 1760 and 1800, affords an interesting indication of the state of scientific and industrial knowledge at the time. Naturally, we now possess a great number of the things for which the Society then offered prizes. Some of these offers produced good results, some were abandoned as utopian, though the machines or articles asked for are now commonplaces of industry and manufacture. Some of the proposals show what our modern conceit may regard as lamentable ignorance, others afford evidence of considerable shrewdness; others, again, indicate a quite natural incapacity to realise the direction of future progress.

That in the lists so many familiar names are missing is certainly disappointing. One would like to have found the names of Watt, Hargreaves, Crompton, Roebuck, Arkwright and Cort, amongst those whose inventions were recognised and rewarded by the Society of Arts. But in the early records none of these names appear. Why is this? The best reason that can be suggested is that all these men were in advance of their time. Like all great inventors, they had to wait for recognition until they had overborne the opposition of ignorance and of rival interests. When recognition came, it was too late for the prize or contribution which would have eased the early struggles. A committee which could anticipate the direction in which industry or science would progress would have to be composed of men with prescience beyond their fellows, and they would not have received the acquiescence or approval of their contemporaries.

It has always been so throughout the history of invention. The great inventor must, of necessity, be a man with ideas ahead of his contemporaries. He has never had their sympathy or their appreciation. On the contrary, he has always had to struggle against their active opposition. If his invention, as has generally been the case, has for its prime object the substitution of mechanism for human labour, he incurs the violent hatred of those who can only realise that their livelihood is being taken away from them.

The history of the introduction of textile machinery, by which millions of operatives now make their living, is a record of the attempts of the progenitors of these operatives to wreck the new machinery, and, if possible, to murder the man who designed it. As long ago as 1710 the Spitalfields weavers rose in riot and smashed their frames in protest against the introduction of improvements. A hundred years later, in 1816, the Luddite riots—after the wholesale destruction of factories and machinery in the Nottingham district—were only suppressed by the stern expedient of hanging a number of the ringleaders.

In the first half of the nineteenth century the hatred of new machinery was combined with strikes, often justifiable enough, for better pay, but certainly for nearly three centuries—since

* "Register of Premiums and Bounties," 1754–1776.

† This is a quarto volume with a collection of fine illustrations in folio. In 1782 another edition was issued by A. M. Bailey, who succeeded his father as Registrar in 1773. It is in two volumes, folio. In this second edition, the list of premiums is not carried beyond 1770.

‡ Vol. I. p. 365.

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James Lee invented his stocking frame in 1589—the workers of the textile trades have done their very best to prevent any improvement in the tools of those trades. If the spinners and weavers had had their own way, all yarn would now be spun by the spinning wheel and woven on the hand-loom. The artisan fought for the ancient system of economic organisation, for domestic industry and handwork. Forces were too strong for him. The growth of capital and its systematical industrial application conquered in the end, but only after a long struggle against excusable ignorance and natural incapacity to appreciate the inevitable.

And the opposition did not come from workmen alone. Manufacturers a hundred and fifty or two hundred years ago, were no more anxious to change all their methods and scrap all their machines, than they are now. When an invention had proved its value, and had been taken up by the more enterprising manufacturers, the rest had perforce to follow suit, but in the meantime the original inventor had had but a poor time of it, and in all probability had died a pauper.

Nor did the inventor as a rule get much sympathy from the general public, or even from those members of the public who might have been expected to know better. After some centuries of mechanical and scientific progress we have perhaps learnt the lesson. Nowadays we are so accustomed to the rapid multiplication of scientific inventions that we readily accept any marvel, however marvellous. Yet there can be hardly any great invention which has not been condemned or depreciated by a competent and well qualified authority. The working of the same spirit may be traced from the beginning of the industrial revolution down to our own day. When Dr. Lardner demonstrated beyond cavil that no steamship could carry coal sufficient to take her under her own steam to America, the statement was accepted as the opinion of one of the best authorities of the time. The heads of the Admiralty declined to consider the use of the electric telegraph because the excellent and efficient semaphore arrangement fulfilled all their needs. We might have had mechanical transport on roads fifty years before it was accomplished, but for the opposition—partly interested and party ignorant—to the early constructors of road locomotives. A year or two before the incandescent filament lamp was perfected the best authorities were agreed that the "subdivision of the electric light" was impossible. The internal-combustion engine found but small favour amongst the older mechanical engineers (there was one brilliant exception). The idea of a "rotary steam-engine" was regarded with derision before the steam-turbine was perfected. The members of the old Aeronautical Society were for years looked upon as harmless visionaries. When the first paper on the basic process of steel-making was offered to the Iron and Steel Institute, the council of that body, a competent tribunal if ever there was one, declined to accept it.

Other instances might be cited, but these may serve to show the value of contemporary opinion on new discoveries, and the extreme difficulty of forming a sound judgment as to the direction which future progress in the application of science to industry is likely to take.

What can we expect if we go back a hundred and more years into a non-scientific age, when men were beginning dimly to realise the value of machines, and to recognise that the processes which had for centuries been wrought by human hands alone might possibly be aided by inanimate mechanism if it were only possible to devise it? What wonder, then, if those who were most anxious to improve the manufactures and industries of their country could imagine no better means than to reward small improvements in the crude existing appliances, and could not imagine a development which astonished their successors, or foresee an advance which we, a century later, regard with wonder and admiration?

Another reason which prevented the Society from taking cognisance of many important inventions was the regulation which excluded patented articles. In one of the earliest lists of Rules and Orders—that for 1765—it was expressly laid down that "No person will be admitted a candidate for any premium offered by the Society who has obtained a patent for the exclusive right of making or performing anything for which such premium is offered." This rule continued in force until the year 1840.

So strong was this feeling of opposition to patents carried that it was at one time proposed to require every prizewinner to agree not to take out a patent, but this proposal was negatived. In later years, when patents became more numerous, the restrictive effect of this rule became much more injurious than in 1765 (in which year only fourteen patents were granted), but even at that time it shut out many valuable improvements. However, the notion that the grant of a patent was an injurious restriction on industry, only to be condoned if the public could not get the benefit of a useful invention unless

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it bribed the inventor with a monopoly, survived long after the end of the eighteenth century. Indeed, it was only in our own generation that the value of protection by patent was fully realised, and that—to quote once more an often-quoted saying of the late Sir William Siemens—if an invention were found lying in the gutter, it would be worth while to assign it to an owner who would have an interest in looking after it. Of course, this general statement, like all such statements, has its exceptions. Some inventions do not need a foster-mother. A case in point is that of the safety-lamp, for which Sir Humphry Davy refused to take out a patent. The need was so urgent, its fulfilment so complete, that no advocacy or advertisement was wanted. But the invention of the safety-lamp was exceptional, not only in this respect.

On the whole, we should admire the amount of useful work done by the Society's premiums rather than cavil because it did not accomplish more. What it really did effect may be judged from the following selection of the more interesting or more important of the subjects to which its energies were devoted. The task of selection has been by no means easy. Its successful accomplishment would demand an amount of technical and expert knowledge to which the present writer can make no claim. The examples chosen out of a century's work may, however, show how much was really accomplished, and how much those earnest industrial pioneers effected who worked in the name and on behalf of the Society of Arts.

The period covered is just a hundred years, from the foundation of the Society to the 1851 Exhibition. Of this period the first half was by far the more fruitful, and it is really to this half that our attention must principally be directed. By the expiration of the eighteenth century the system of prize-giving had practically fulfilled its work. It gradually became less and less effective till at last it died out. The work of the Society tended in other directions. For some years the Society languished; indeed, it nearly collapsed, to be revived again in the middle of the nineteenth century. The record of these changes is, however, a matter for future consideration. For the present we are concerned only with the history of the useful work effected by the Society during that first prosperous portion of its career, when its sole aim and object was the awarding of premiums for the promotion of Art and Industry, and the discovery of suitable objects for such awards.

Of all the inventions upon which, at the time when the Society commenced its work, the advance of industrial progress principally depended, the most important were certainly those dealing with the generation and application of motive power, and yet it was not to these inventions that most attention was directed. If those who devoted themselves to this department of the Society's work were unconscious of the impending change shortly about to be effected by the substitution of mechanical for animal power in every branch of industry, it is not to be wondered at. The modern steam-engine and the Society of Arts were almost absolutely contemporaneous. James Watt began his scientific career in the year in which the Society was founded, though it was eleven years later that he conceived the idea of the separate condenser, and four years later still (in 1769) that he took out his first patent.

In 1754, the need for some agency which could drive heavier machinery than could be worked by a man or a team of horses was hardly existent, and almost wholly unrealised. Yet it must, to some small extent, have been in men's minds, and we may find evidence for this in the desire to improve those elementary methods for utilising the known natural forces, wind and water, which showed itself in the work of the earliest engineers—millwrights, as they were called—and in the technical literature, such as it was, of the time. Amongst other places, we find it in the Society's premium list. The list for 1759 contains two offers of £50 each, one for a tide-mill, and one for an improved windmill, which should more effectively utilise the force of the wind than previously existing forms, and should also, with varying wind-velocity, communicate a uniform motion to the mill-shaft. As a result of these offers, several rewards were paid, one for a tide-mill going to the Rev. Humphry Gainsborough,* a brother of the painter, who seems to have been an inventor of considerable ingenuity. These and similar offers were repeated from time to time during the next fifty years, and various sums of money were paid for improvements in windmills and also in water-wheels. Dr. Erasmus Darwin corresponded with the Society at one time about his idea of a horizontal windmill, but no award was made to him. It is some time before the steam-engine makes its appearance in the list. In 1780 we find a gold medal offered for an engine for "working at one time, the greatest

* He was a friend of R. L. Edgeworth's, who says that he had never known "a man of a more inventive genius."—Edgeworth's "Memoirs" (1821, Second Edition, p. 153).

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number of looms, not fewer than three." The offer was continued for some time, but there is no record of a prize ever being awarded. As a matter of fact, the first recorded use of the steam-engine in a factory is in 1786. Cartwright's power-loom was brought out in 1785, and was driven by steam in 1790. John Austin of Glasgow, also claims, in a communication to the Society,* to have constructed a power-loom in 1789, and to have had one running in 1798 at Pollokshaws, near Glasgow. He adds that, after this, a building was constructed to hold two hundred of his looms at the same mills. He received a gold medal from the Society in 1806. It is probable that the first to invent a power-loom was John Kay, whose patent of 1745, taken out jointly with Joseph Stell, included, as Kay himself says, "tape lomes to weave by water."† No description, however, of Kay's loom is extant. Kay was, at all events, indirectly the inventor of the power-loom, because it was his fly-shuttle that enabled a mechanical movement to be substituted for the action of the human hand.

Up to the end of the century references to the steam-engine are rare. A vague offer of a reward for "increasing the force or quantity of steam" in steam-engines was published in 1783, and long kept its place on the list, but it elicited no response. Would a modern triple-expansion engine or a turbine be eligible for the prize? They utilise the energy, but cannot be said to increase it.

The first substitution of mechanical power for handwork in the timber trade in England is certainly due to the Society. A premium for a saw-mill was awarded to James Stansfield in 1761, and sums amounting in all to over £300 were given to him to help him in improving and working his mill. By the instrumentality of the Society, Stansfield was also introduced to one Charles Dingley, who found the capital for setting up a mill at Limehouse, which was driven by wind-power. This mill, after working a short time, suffered the usual fate of all mechanical improvements, and was destroyed by a mob, but the owner was compensated, the rioters punished, and the mill reinstated.‡ For his services in the matter, a gold medal was awarded to Dingley. The backward state of English industry is shown by the fact that saw-mills worked by water and by wind had previously been in existence on the Continent, and even in America, though there seems reason to believe that Stansfield's was an improvement on the older types.

That eccentric mechanical genius Richard Lovell Edgeworth received several rewards. The most important of these was a gold medal awarded in 1769 for various inventions communicated to the Society. What these were, it is not very easy to say. It is just possible that one of them was a proposal for a steam carriage, which seems to have arisen out of a suggestion by Dr. Erasmus Darwin, who was a friend of Edgeworth.*

This, however, is not mentioned by Edgeworth himself, who, in his "Memoirs,"† enumerates only a carriage with springs and a new form of frame, a waggon "divided into two parts," a cover for haystacks, and a turnip cutter. He also says that he afterwards submitted a dynamometer, and from a letter of his it appears that he suggested a new form of camera-obscura.

For his "Perambulator, or instrument for easily measuring land," he had a separate silver medal in 1767. The idea of using a wheel for the purpose was not novel. Such an apparatus was known in the seventeenth century, and was called by the same name. Edgeworth's machine consisted of a wheel, or rather a framework of spokes without a tyre, to the axle of which was fitted a long screw projecting horizontally. A nut loosely fitted on this screw was prevented from revolving with it, when the wheel was run over the ground, by a suspended weight, so that the motion of the wheel caused the nut to travel along the screw, one thread for each revolution, and the distance traversed was thus indicated. The apparatus would, no doubt, be effective, but it must have been clumsy, and rather inconvenient to work. The circumference of the wheel was to be one pole ($5\frac{1}{2}$ yards).‡ In the "Memoirs" he states (p. 171) that the instrument worked with great accuracy, having run over a measured mile twice with a difference of only one inch between the two results. Edgeworth's eldest son Richard also received a silver medal in 1778, "for early mechanical genius shown in the constructing several models and machines." As he was born in 1765, he must have been about thirteen years old at the time. This reward seems to have remained unique.

* *Transactions*, Vol. XXIV. p. 93.

† *Journal*, December 8th, 1911, p. 81.

‡ *Dossie*, Vol. I. p. 113. *Transactions*, Vol. I. p. 41.

* Thurston, "History of the Steam Engine" (1879), p. 150.

† Edited by Maria Edgeworth (1821, Second Edition, p. 167).

‡ There is an illustration of the apparatus in Bailey's "Machines, etc.," Vol. I. p. 59 (edition of 1782).

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The award of a gold medal in 1770 to Abraham Staghold for a screw-jack is of peculiar interest, because the jack, which is figured and described by Bailey,* is identical with the well-known modern implement, which, many years after Staghold's invention, was the subject of a patent. The vertical screw is operated by a worm-wheel working thereon as a nut, which worm-wheel gears with a horizontal worm driven by a winch-handle. Abraham Staghold was a blacksmith of Maldon, in Essex, and appears to have been a man of considerable inventive ingenuity, for he was also the inventor of the gun-harpoon, for which he received a grant of twenty guineas in 1770. His inventions, however, do not appear to have brought him a fortune, for in 1774 he sent in a petition to the Society, "desiring relief in his state of distress." The Committee on Correspondence were unable to recommend the Society to devote its funds to a charitable purpose, so the unlucky inventor got nothing by his application.

The first award for a gun-harpoon was followed by several others. For many years the Society continued to offer prizes for improved forms of the apparatus, and they also spent over £100 in experiments and tests.

As soon as a satisfactory weapon had been obtained—and this involved many details both in the gun and in the harpoon—they continued to offer rewards for whales taken by its use. One of the recipients of these grants, Captain Humphrey Foord, of Hull, wrote a very interesting account of his experiences with the new weapon, and made several pertinent suggestions for its improvement. He concludes his letter with a quite unnecessary apology for "the blunders of an illiterate tar, who is unacquainted with writing to the great."

Up to 1792 something like £400 had been expended, but after this the number of claimants diminished, and though the offer was not discontinued till 1821, the awards made in later years were few and the amounts paid inconsiderable.

Scoresby, in his history of the northern whale fishery,† gives an account of the Society's efforts to introduce the use of the gun-harpoon. He says that the weapon was invented in 1731, and was used with some success. "Being, however, difficult and somewhat dangerous in its application, it was laid aside for many years. In 1771 or 1772, a new one was produced to the Society of Arts, which differed so materially from the instrument before in use that it was received as an original invention." On the whole, Scoresby says, in spite of the great improvements resulting from the Society's premiums, "on account of the difficulty and address requisite in the management of it, and the loss of fish, which, in unskilful hands, it has been the means of occasioning, together with some accidents which have resulted from its use, it has not been so generally adopted as might have been expected." Later on, still further improvements were made, and at the date of Scoresby's writing (1820) it was coming to a certain extent into use. At the present date, under the different conditions of the whale fishery, the gun is always employed, to the practical exclusion of the old hand weapon.

Just about the end of the eighteenth century a great deal of attention was paid to the subject of mechanical telegraphs.* The first suggestion for such a method of conveying intelligence was made by Robert Hooke, who described, in a paper before the Royal Society in 1684, a method of exhibiting signals to be observed through a telescope, which, though rather complicated, might have been perfectly efficient had it ever been put into practice. The credit of making the first practical telegraph may be assigned to R. L. Edgeworth, who, as has been already mentioned, received several prizes from the Society. There is, however, no evidence to show that he submitted his telegraphic system to the Society. He says in his "Memoirs" that his attention was first drawn to the subject by a bet that he could report in London the result of a race at Newmarket before it could be brought by mounted messengers. Later on he described his method in the Transactions of the Royal Irish Academy (Vol. VI. 1795). In his system it was proposed to use four triangular pointers, each pivoted to the top of a mast, and representing units, tens, hundreds, and thousands, the precise figure being indicated by the position of the pointer. These numbers corresponded with words or sentences in a vocabulary.

The mechanical telegraph, however, was first introduced by a Frenchman—Monsieur Chappe—about 1794. Several lines of his telegraph were set up, and it was regularly used for military purposes. According to his system, six discs

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* Bailey's "Machines, etc.," Vol. I. p. 168 (edition of 1782).

† "The Arctic Regions," by W. Scoresby (1820), Vol. II. p. 227.

* *Rees's Cyclopædia*, Vol. XXXV. (1819) has a very full and excellent account of mechanical telegraphs. Most of the Society's awards are mentioned.

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were mounted side by side in a frame in such a way that either or all of them could be turned edgeways, so as to be practically invisible, or vertical so as to be seen. By various combinations of these discs a great number of signals could be sent. For use at night, lamps were substituted for discs. A practically similar arrangement was submitted in 1805 to the Society by J. Davis, and he received a silver medal for it. Two other awards were made by the Society in 1808—a silver medal to Major Le Hardy for a rather ingenious device for indicating numbers by means of index discs capable of being set in different positions on a polygonal frame, and a silver medal to Chevalier Edelcrantz, a Swede, for a telegraph composed of vanes or shutters capable of being turned edgeways.

Two awards made in 1809 are also worthy of notice, because they refer to methods of hand-signalling. In one of the communications Lieutenant James Spratt, who was wounded at Trafalgar, describes a method of signalling by a handkerchief held in different positions; and in the second, Knight Spencer submitted what he termed an "anthropo telegraph"—a method of signalling by different positions of the arms.

The device, however, which superseded all of these was that invented by Admiral Sir Home Popham, which received a gold medal from the Society in 1816. This was a semaphore arrangement, in which two masts were employed, each with an arm capable of being set up at any desired angle to the vertical. It was by this apparatus that information was transmitted from Portsmouth and elsewhere to the Admiralty, until it was at length superseded by the electric telegraph. This was the apparatus with which Barrow (not yet Sir John) was so well satisfied, that when Ronalds in 1816 offered to the Admiralty his pith-ball telegraph, which was really the first practical electric telegraph, Barrow, then Secretary to the Admiralty, wrote, with his compliments to the inventor, "that telegraphs of any kind are wholly unnecessary, and that no other than the one now in use would be adopted." This historic communication is dated August 5th, 1816.*

The list of awards connected with mining is not a very long one. There were a few inventions for raising water from mines, the most important of these being William Westgarth's hydraulic engine, for which a gold medal was awarded in 1769. Nearly twenty years later, in 1787, a silver medal was presented to Smeaton, the great engineer, for a description of the apparatus which he communicated (after the inventor's death) to the Society.* Smeaton had a very high opinion of the value of the apparatus which, he said, was much appreciated in the Cornish tin-mines. Various methods of raising minerals were also rewarded by the Society, and described in the *Transactions*. All of these became obsolete when the steam-engine was applied to that purpose.

In 1816 a gold medal and 100 guineas were presented to James Ryan for his system of mine ventilation. Galloway† speaks in terms of high commendation of Ryan's system, which was to drain off the gas by "passages or gas drifts so arranged as to collect and draw off the gas at the highest level." It was largely introduced into Staffordshire, where it suited the character of the coal measures, but in the northern districts, where it was less available, it met with less approval and was not adopted.

The first person to provide miners with a fairly good and safe light was Dr. Clanny, of Bishop Wearmouth. He devised various forms of lamps into which air was forced by a bellows, its exit being controlled by valves of various device. After working for some time at the subject, he described one form of his lamp to the Royal Society in 1813. In 1815 he submitted an improved form to the Society of Arts, and received a silver medal, while in 1816 he was awarded a gold medal for a steam safety-lamp. These various devices were undoubtedly valuable and of practical utility, but they never came into general use. They were soon quite superseded by the safety-lamps of Davy and Stephenson, both of which were invented independently in 1815.

Civil engineering also hardly received its due meed of attention from the Society. The Duke of Bridgewater in 1800 received a gold medal in recognition of the great system of canals which he constructed, a well-deserved award, though, perhaps, it might have been more fittingly bestowed upon Brindley, the great engineer, whose genius was so wisely utilised by the Duke.

In 1788 a gold medal was given to Abraham Darby, for the iron bridge he built over the Severn, near Coalbrookdale. This was the first iron bridge ever constructed. The beautiful model which Darby presented to the Society is now in the Victoria and Albert Museum.

The award in 1762 of fifty guineas to G. Weldon for a machine for planing cast-iron

* "History of Electric Telegraphy," J. J. Fahie (1884), . 136.

* *Transactions*, Vol. V. (1787), p. 181.

† "History of Coal Mining" (1882), p. 135.

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is of interest, because it seems likely that this is the earliest true planer of which there is any record. No picture or description of the machine has been discovered in the Society's records, but Dossie* says that "It planed large iron plates as effectually as a common plane does boards; making curled shavings, and completely smoothing the surface of the plates."

As might naturally be expected, a good deal of attention was paid by the Society at the end of the eighteenth and the beginning of the nineteenth century to questions of naval construction. The old records of the Society show that it was frequently consulted by the naval authorities on questions of timber for use in building the King's ships, and such information as the Society could furnish was readily supplied. Some important awards were made by the Society in the class of naval architecture. In 1759 a prize offered for "Ships' Blocks," that is to say, models of ships of new construction, was awarded to Joseph Aldridge, and in 1804 a gold medal was voted to Robert Seppings (afterwards Sir Robert, and Surveyor of the Navy) for his invention of suspending instead of lifting ships in dock.† For this Seppings was granted £1,000 by the Admiralty. It was the first of many important inventions which gained him the reputation of being the greatest naval architect of his time. It was he who first introduced the extensive use of iron in the construction of ships, which, by the additional strength provided by his diagonal braces and trusses, prevented the arching of their keels, technically called "hogging," which always occurred when ships were laid by. Although in the use of iron for shipbuilding he had been partly anticipated by T. Roberts (Assistant Surveyor to the Navy)—who in 1808 received the Society's silver medal for "attaching the end of the beams of ships to their sides by iron instead of wooden knees"—it was Seppings who really revolutionised the art of shipbuilding by the extended use of iron framing. The "Howe," launched in 1815, was the first ship built entirely on Seppings's system, although it had been partially applied before that date.

As may be supposed, a great variety of mechanical and engineering inventions besides the few mentioned above received awards from the Society. In the first half-century of its existence these included corn and other mills, canal locks, dredgers, cranes, pile-driving machines, carriages of many sorts, a packing press, tools of many descriptions, mechanical movements, locks, clocks and watches, etc.

Later on, in the early years of the nineteenth century, most of the mechanical inventions submitted to, and rewarded by, the Society, were of a minor character, though many of them were valuable. The offer of a prize for an original screw brought out several methods for obtaining one, but not of the accuracy required for astronomical and other scientific purposes. There were many awards for improvements in clocks and watches, devices for cutting wheels for watches, watch-springs, etc. The prizes connected with lathes and turning were also numerous, including chucks, self-centring and other. Various mechanical appliances and devices now well known and familiar were brought out by the Society's awards, and descriptions of them will be found in the pages of the *Transactions*.

[NOTE.—The next instalment of this chapter will deal with Textiles, Industrial Hygiene, and Chemistry.]

(To be continued.)

* Vol. I. p. 161. A note on early planing machines, and some references to authorities, will be found in "Industrial England in the Middle of the Eighteenth Century," p. 27.

† *Transactions*, Vol. XXII. (1804) p. 275. See also Seppings's Life in the "Dictionary of National Biography."

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE CARBONISATION OF COAL.

By VIVIAN B. LEWES,

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Lecture IV.—Delivered December 18th, 1911.

THE POSSIBLE IMPROVEMENTS IN CARBONISATION.

If we distil coal at a fixed temperature, as has been pointed out, we know that in the distillates we have the volatile products yielded at all temperatures below the one employed, and such secondary products as have been formed by further decompositions, or by interactions between the primary products at or below that temperature; so that if we distil coal in bulk at the lowest temperature at which volatile matter can be driven out from the coal, the analyses of the products will give us the maximum of primary products with the minimum of secondary, and we shall obtain the best possible data for forming an opinion as to the composition of the coal, on the one hand, and the course taken by

the interactions and decompositions, on the other, in the secondary actions.

In the experiments that led to the introduction of coalite it was found that 420° C. (800° F.) was the lowest temperature that could be employed successfully, and many thousand tons of coal have been distilled at about this point, say from 400° to 500° C.

Under these conditions a fair gas coal, containing 30 to 33 per cent. of volatile matter, will yield 68 to 70 per cent. of low temperature coke, containing 10 to 14 per cent. of volatile matter, and a volume of gas varying from 5,000 to 5,000 cubic feet, according to the coal used, having a composition approximating to :—

Hydrogen		27·5
Saturated hydrocarbons—		
Methane	48	
Higher Members	10·1—58·1	
Unsaturated hydrocarbons		3·0
Carbon monoxide		7·3
Carbon dioxide		2·5
Nitrogen		1·6

The gas before iron purification contains about 1·8 per cent. of sulphuretted hydrogen.

The low temperature gas of course varies with the coal used, and the hydrogen is often below 18 per cent., and the saturated hydrocarbons up to 68 per cent., but the marked feature of the gas is that it contains hardly any benzene vapour, and owes its illuminating power to a small percentage of ethylene, and chiefly to the gaseous members of the paraffin series (mostly ethane), and also that the percentage of hydrogen per ton, and in most cases averages twenty gallons.

The low-temperature tar is as distinctive in its characteristics as the gas. It has a specific gravity of about 1·075, is very liquid, and contains an abundance of light solvent oils, very low aromatic hydrocarbons, very little phenol but large quantities of cresol, no naphthalene, and very little anthracene, whilst the free carbon is as a rule below 2 per cent.

The very low percentage of benzene in the light oils is made up for by the presence of paraffins, such as hexane, heptane and octane, whilst there are also present considerable quantities of that curious group of hydrocarbons known as naphthenes or hexahydro-benzenes, which play so important a part in Russian petroleum.

As before mentioned, carbolic acid occurs in very small quantities, but its higher homologues, such as cresylic acid, etc., occur in much larger quantities than in coal tar; and there are also present quantities of polyhydric phenols, or other esters of the type met with in coal tar, which form resinous masses difficult to investigate. The pitch left as a residue amounts to about 40 per cent. of the tar, and is of very fine quality, owing to the practical absence of free carbon.

A very complete investigation of this low-temperature tar has been made by Mr. J. S. S. Brame in the laboratories at Greenwich, and will be published elsewhere.

The average tar yielded by the coal gave on distillation the following results :—

Specific gravity 1,073

Distillation on 2,274 c.c. (0·5 gallon).

		By volume on tar.	Specific gravity.	Volume of hydrocarbons.	Tar acids recovered.
Water		2·64			
Light oil	to 170°C	3·10	·844	3·10	
Carbolic oil	170°—225°	13·72	·959	8·62	4·8
Creosote oil	225°—240°	8·35	·9885	4·64	3·1
Creosote oil	240°—270°	8·35	·9923	5·45	2·55
Anthracene	270°—300°	8·80	1·029	6·60	1·76
Anthracene	300°—320°	12·31	1·033	8·80	3·10

Pitch, by weight on volume . . . . 41·71

Bases recovered . . . . 1·32 per cent.

is low, very rarely reaching the amount present in the above sample, whilst bisulphide of carbon likewise is very low.

This I pointed out in the last course of Cantor Lectures which I gave in March, 1908, and it has since been confirmed by the work of Porter and Ovitz, White Park and Dunkley, and Burgess and Wheeler.

The tar also varies with the coal used, and is sometimes as high as twenty-three gallons

Light oils— percentage distilling below.			Calculated on Tar.	
100°C	15·6 by volume		0·55	
120°	31·2		1·09	
140°	54·7		1·91	
170°	82·8	100·0	2·90	3·10
over 170° and loss	17·2		0·20	

The ammonium sulphate amounted to only 12 lbs. per ton of coal, the temperature being too low for large production.

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From these results it seems more than probable that the primary products of decomposition of the coal are those which are produced during the actions taking place in its formation, *i.e.*, methane, carbon dioxide and water, plus those compounds formed by the rising temperature and consisting of the first nine or ten members of the paraffin series, naphthenes and oxygenated hydrocarbons like cresylic acid. The action of heat upon these starts at once secondary reactions, and gives us gaseous and liquid compounds identified in low-temperature gas and tar, whilst at higher temperatures these in contact with the highly heated coke envelope of the decomposing coal undergo further actions, analytic and synthetic, and becoming diluted with poor gas from the residual pitch left in the coalite, yield the high-temperature coal gas and tar.

When coalite that has been formed with the evolution of 5,000 cubic feet of 22 candle-power gas, as measured by the No. 2 Argand, is further heated to a high temperature, it evolves nearly as much gas as it did before, and the composition of this gas is approximately:—

Hydrogen	71·13
Saturated hydrocarbons	18·26
Unsaturated hydrocarbons . . .	0·52
Carbon monoxide	6·30
Carbon dioxide	2·09
Nitrogen	1·70

The gas is practically non-luminous when burnt alone, but has a heating value of 447 B.Th.U.

It seems clear from these experiments that in the distillation of coal for gas, there are three distinct sources which give the final product:—

1. The primary gases evolved from the coal, and distilled out as the advancing temperature travels through the mass.

2. The gas evolved by the decomposition of the heavy tar or pitch left in the coking mass.

3. The gas produced by secondary actions, and contact of the primary gases and vapours with the hot coke and walls of the retort.

It now becomes possible to trace roughly the actions taking place in the destructive distillation of a gas coal. Up to about 450° C. the products are chiefly primary (see table below).

About 400° to 450° C. the secondary actions start, the saturated hydrocarbons split up into unsaturated and simpler members of the saturated series, the hexahydrides shed hydrogen and give aromatic hydrocarbons, the tar thickens and alters in character, and synthetic actions start, cresol and hydrogen form more toluene, carbolic acid and carbon yield carbon monoxide and benzene. About 900° C. the degradation of all the hydrocarbons and other oxygenated bodies is proceeding, and finally the mixture of the results of endless actions and reactions yields us the high-temperature gas and tar, the mixture being diluted with the carbon monoxide, hydrogen and methane yielded by the decomposition of the pitch residues in the soft coke, which leaves the hard coke behind.

All our carbonising processes, from the horizontal retort to the latest oven or chamber process, are smirched with the same defect, and that is the after-effect of heated surfaces and red-hot coke on the gas.

I have elaborated in much detail the fact that there is not a single factor of uniformity in our ordinary methods of carbonising, and there never can be with most of the proposed new processes. The coke-oven manager is in much the same plight, but he does achieve to a great extent what he is aiming at, and that is, to keep all the carbon he can in the coke. The gas-manager's aim is just the reverse; he desires all the carbon he can obtain in the gas, and few of the proposed methods of carbonisation go the right way to secure it. Indeed, the only approach to it is in continuous carbonisation.

No matter what temperature is used—the heats may be pressed as high as the material of

	Humus Bodies.		Resin Bodies and Hydrocarbons.
Carbon . . .	Water Carbon monoxide Carbon dioxide Hydrogen Methane	Gases . .	Methane. Ethane. Propane. Butane.
Coke and pitch .	Watery tar . .	Liquids . .	Pentane. Hexane. Heptane. Octane. Nonane. Hexahydrides. Oxygenated hydrocarbons, like cresylic acid and more complex bodies.

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the retorts and flues will stand—the temperature of the distillation of the coal will be the lowest temperature at which it evolves gas, and if one looks back to Lewis Thompson Wright's classical work on the influence of temperature on carbonisation, it will be found that the coal fed into a retort at the highest attainable temperature gives for the first ten minutes a rush of gas having much the same composition as coalite gas:—

	Time after commencement of Carbonisation.			
	10 minutes.	1 hour 30 minutes	3 hours 25 minutes.	5 hours 35 minutes.
Hydrogen	20·10	38·03	50·68	67·12
Methane	57·38	44·03	35·54	22·58
Hydrocarbons	10·62	5·98	3·04	1·79
Carbonic oxide	6·19	5·98	6·21	6·12
Carbonic acid	2·21	2·09	1·49	1·50
Sulphuretted hydrogen	1·30	1·42	0·49	0·11
Nitrogen	2·20	2·47	2·55	0·78
	100·00	100·00	100·00	100·00
Carbon density of hydrocarbons	2·86	3·11	3·38	2·29

which at this temperature is capable of producing 1,200 cubic feet of gas, leaving 300 cubic feet to represent the volume gained by degradation of gaseous hydrocarbons and deposition of free carbon, of which the high temperature tar contains 25 to 35 per cent.

It may be taken in round numbers that when 11,000 cubic feet of gas are obtained per ton of such a coal, 45 per cent. of the volume is from the low temperature distillation; 42 per cent.

It will be seen that not only is the gas driven off in the first ten minutes of the charge nearly identical in composition with coalite gas, but also that the gas yielded in the last period of carbonisation is nearly the same as the gas obtained by the further distillation of the coalite, whilst during the intermediate five hours of the charge the gases evolved have been mixtures of the primary gas in various conditions of secondary change diluted with the residual gas from partially coked coal on the exterior of the charge, the secondary changes being brought about by contact between the primary gas, the tar vapours, and the wall surface, passage through the skin of red-hot coke, and radiant heat.

With a good Durham coal capable of yielding 11,000 cubic feet of gas and ten gallons of tar per ton when distilled under ordinary conditions, at a temperature of about 1000° C., it is found that on carbonising at 600° C. it yields only 5,000 cubic feet of gas, but 22 gallons of tar per ton, and the residue, on continuing the distillation at 1000° C., yields a further volume of 4,500 cubic feet of gas, but no tar; so that removing the gas first formed and the tar vapour from the secondary reactions induced by high temperature has reduced the gas yield by some 1,500 cubic feet per ton, and increased the tar yield by 12 gallons, and an examination of the tar shows that the 12 gallons gasified by direct distillation at high temperature consist of the lighter portions of the whole of the tar, from the residues left in the low-temperature coke distilled at a high temperature; 13 per cent. from the various secondary actions and tar.

When tested by the No. 2 Argand, the low-temperature gas has a candle-power of 22, the gas from the pitch in the coke is nearly non-luminous, giving not more than 2½ to 3 candles, but when mixed with the rich gas in the proportion of 45 of the latter to 41 of the former it gives a 16 to 17-candle gas, whilst the gas from the tar and the secondary action is 10-candle gas when tested alone, and when mixed with the others brings down the total candle-power to 14 to 15 candles.

In the new methods of carbonisation, where the makes approximate to 13,000 cubic feet, the improvement found is entirely due to the free escape without over-heating of the products from the first two-thirds of the coal carbonised, whilst the extra volume is obtained from the complete degradation of the products from the remaining third, and that this is so is shown by the methane in the gas. In all fair coal gas in which there has been no over-degradation, even if you have been getting 11,500 cubic feet per ton from light charges, the methane will be about 34 to 35 per cent. of the gas, but notice the products of the new carbonisation, and you will find plenty of samples with only 28 per cent., and some even lower.

In considering the ultimate effect of pushing temperatures to the highest possible extent, it is well to consider the amount and value of the

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gas and coke that could possibly be obtained from an ordinary coal:—

If we took a coal of the consumption—

Carbon	80
Hydrogen	5
Oxygen	10
Nitrogen and ash	5

and were to carbonise it in an inverted vertical retort with the coal fed in by a ram at the bottom, so that the gas and vapours had to traverse a column of 10 ft. of coke at 1000° C., contact would decompose all the gaseous and volatile compounds to hydrogen and carbon monoxide, and we should obtain:—

Coke.	15·27 cwt.	
Hydrogen	22,400 cubic feet	= 77·87 per cent.
Carbon monoxide	6,366 ,, ,,	= 22·13 ,, ,,
	28,766	

that is, you would rather more than double the volume of gas, but it is a non-luminous gas of the same thermal value (gross) as water-gas, and not worth more than the 3½*d.* to 4*d.* a thousand, that you could make water-gas at by one of the newer processes.

Certainly you get an increase in the quantity of coke, and it would be an excellent metallurgical coke.

Now, this is exactly what is done in all the new processes directly the cool passage for the escape of the primary gas gets tar-logged, and the gas from the remaining coal is driven through the red-hot coke and along the sides of the retort. Under these conditions some 3,500 cubic feet of 22-candle gas are obtained, whilst there is a free cool passage for its escape, and after that is closed the remaining coal yields by complete degradation of the tar and hydrocarbons 9,500 cubic feet of hydrogen and carbon monoxide, and you take a pride in your 13,000 cubic feet, instead of being heartily ashamed of it.

Of course, there is the saving factor that between the good primary gas and the relics of ruined hydrocarbons there is a good deal of only partly destroyed gas from the coal and tar near to the mouthpiece, so that the make averages out at 15 candles, and the cool distillation of the tar from the first two-thirds of the coal yields two-thirds of the 20 gallons that would have been obtained had it all been distilled in the same way, and this is the secret of the new process, tar being 13 to 14 gallons per ton more liquid and more paraffinoid in its nature.

In continuous carbonisation it is claimed that degradation does not take place, but the make and the methane in the gas tell their own tale, and the fact that the charge is always fairly cool in the top three feet of the retort, and is of nearly the full breadth of the retort, is made up for by the rapid tailing of the uncarbonised portion, which soon makes the cool inner core an impossibility, whilst it must be tar-logged for a considerable distance.

During the past few years a perfect tornado of results from every kind of carbonising process has burst upon the gas world, and as the same class of coal has hardly ever been used, and as the experimental methods have differed even more widely than the coal, the results, as a basis of comparison between the various processes, have been for all practical purposes of little or no use.

In order to obtain from these results something like a comparison, I have taken the figures obtained by the most practised observers, and have translated them by comparison into terms of a good North-Country gas coal, carbonised to give a yield of 15 candle-power gas, as tested on the Metropolitan No. 2 burner, and having a thermal value of 540 B.Th.U. gross, taking the results to the nearest 500 cubic feet:—

Gas Make.

Horizontal 6-hour charges.	Horizontal 12-hour charges.	Intermittent verticals.	Continuous Carbonisation. Woodall-Duckham.	Continuous Carbonisation. Glover-West.	Chamber Carbonisation.
11,500	13,000	13,000	13,000	13,500	12,500

that is to say, the horizontal retort, well filled, gives yields equal to the intermittent verticals, or Woodall-Duckham continuous verticals, and is superior to chamber carbonisation, being surpassed only by the Glover-West continuous vertical retorts, which owe their superiority to the engineering skill with which the various parts are designed and to the regeneration of the secondary air.

When we take the four leading systems and try to differentiate between them by the important item of fuel consumption, we find the best practice gives per 100 lbs. of coals carbonised:—

Horizontal.	Intermittent verticals.	Continuous Carbonisation. Woodall-Duckham.	Continuous Carbonisation. Glover-West.
14	15	12·1	10·3

So that here, as one would expect, the withdrawal of heat from the coke, and utilising it to heat the

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secondary air, gives the Glover-West process an advantage.

If we now take cleanliness of working, amount of nuisance to the neighbourhood of the gas-works, and uniformity in composition of the gas during the period of carbonisation, the continuous vertical retort stands alone.

It is an impossibility to shoot or feed a heavy charge of raw coal into a red-hot retort without getting an outrush of steam and smoke that permeates the atmosphere for a considerable distance, and means not only loss but stench, whilst they also give the further advantage that the coke being cooled in the bottom chamber of the retort needs little or no spraying when drawn, and steam is thus avoided.

The coke, tar, and sulphate of ammonia in all the new methods of procedure are an improvement upon the products from the lightly charged horizontal, so that not only from the scientific but also from the practical point of view the continuous vertical retort processes are the ones that show the real advance, and, what is still more important, they are the ones which offer a promise of improvement.

There are other points, however, which the gas-manager must take into consideration in choosing a process, and these are the cost of an installation, the cost of labour, and the ground space that the installation will occupy.

At present the cost of the vertical retort installation, be it intermittent or continuous, is in most cases just about double that of the horizontal; but, on the other hand, it must be credited with saving in labour and space, nor should it be overlooked that the horizontal retort had had a century of experience lavished upon it, whilst the vertical is in its infancy.

I think I have said enough to show that in my opinion we are well ahead of Continental practice, and if anyone asked my advice as to his present carbonising methods, it would be to use full charges in horizontals until a scrapping of the plant becomes a necessity, and then to instal a continuous vertical retort system.

The ideals to be aimed at in a perfect carbonising process are a uniform treatment of every particle of coal distilled, a uniform treatment of the whole of the gas evolved, and, what is perhaps as important as anything, preventing the degradation of valuable hydrocarbons by contact with hot coke or other surfaces.

I have shown the limitations of the various processes, and there can be no doubt in the minds of those who have studied the question that the continuous vertical retort, when properly proportioned and worked, gives the only solution of the problem of uniformity in treatment to coal and products alike, and if scientific teaching is of any value, they must be the type of gas-making retort in the future.

That, however, is not saying that I consider the two present systems perfect or anywhere near it. Already experiments are being made in several directions to find further improvements. You will have noticed that I have said nothing about such installations as the Glasgow verticals, simply because it would not be fair to discuss them at present.

I have my own ideas as to the lines on which to work in the future, but before I place them before you I want to discuss another side of the question of carbonisation from the gas-manager's point of view, which must be placed in the front as a policy if gas is to do the work I hope for it in the future.

The limit of volume in gas-making, if not already reached, is fast being approached; economies are day by day getting more difficult to make, coal is not likely to cheapen, and all this means that the chance of considerable reduction in the price of gas is getting less and less. If the price of gas could be reduced in our large cities to the price charged at Widnes, the consumption of gas could be economically increased and for power and heat gas would hold an unassailable position, but this can never be done under existing circumstances, because even if the gas could be made at the necessary price, the increased output of coke would outrun the demand; if, however, the companies would only live up to their titles of "Gas Light and Coke Companies," and bestow as much care on the coke as on the gas, and cater for the supply of a good domestic fuel at the price of coal instead of treating coke as a by-product, the demand for it would soon reach a point that would enable the desired reductions in the price of gas to be made. There is no need to fear as to the other by-products; the output of sulphate of ammonia could be doubled without affecting the market, and a good tar will look after itself. It was high heats that ruined the tar market, and with the demand for tar increasing for road work, no flooding of the market need be feared.

During the last few years the statement has several times been put forward that "as the gas-manager's end and aim is gas, it is his duty to obtain the greatest volume of gas possible per ton of coal," but with this I venture to disagree. The gas-manager's duty is to obtain the greatest possible value per ton of coal, and

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until every industry dealing with coal recognises that in this respect their aim is the same, little economy will be possible in our rapidly diminishing store of coal.

The pressing of temperatures in carbonisation to higher and higher degrees with the old conditions of lightly charged retorts has given larger yields of gas, but it has loaded the gas with carbon bisulphide, depreciated the coke, and ruined the tar; and one of the chief claims for the adoption of the full charge horizontals and intermittent vertical retorts for carbonisation is that they have improved the character of both coke and tar.

As I have shown, this is due to a certain proportion of the gas and tar vapour coming off through the cool core, and so escaping over-cracking, but it can be only a partial improvement, whilst, as far as the coke goes, the nearer it approaches metallurgical coke the less it is fitted for a domestic fuel. True it is that where the coke has been made harder and brighter the gas-manager's market has improved, but it has been for use in furnaces, manufacturing processes and for producers that the increased demand has been felt, and not for domestic use.

Even for the heating of the furnaces the coke made at extreme temperatures is not as good as when the heats were slightly lower, and in Germany this is beginning to be recognised, and Körting, in a paper read this summer, points out that the inclined settings, which used to work with 12 per cent. of fuel, now require fully 16 per cent., an increase due partly to higher temperatures, but largely to more highly carbonised coke.

Already the strides forward which gas has made as a domestic fuel are telling the tale in our atmosphere, and the yellow fogs of the last century are getting rarer, and if coke could be made a domestic fuel by leaving in it 6 to 8 per cent. of volatile matter to facilitate ignition and give a flame, the gasworks of the country could command the fuel market.

Remember that the sale of gas cannot be pushed beyond a certain point without over-stocking with coke, the sale of both *pro rata* must be pushed, and if only you could be persuaded that this is the right road, you would be backed up by the smoke reformers and the public, and find yourselves able to sell a fuel coke at the price of the best coal.

I have shown that the factor for which you ruin your coke as a domestic fuel is about 3,000 cubic feet of gas of the same value as blue water gas, the 3,000 cubic feet of gas left in the coke would be worth four or five shillings a ton on the selling price, and the cost of replacing it by water-gas would be about one shilling, whilst the creation of a large domestic market would enable a reduction in the price of gas to be made that would still further increase its use as a fuel.

Now, I am sure in my own mind that these are the lines the gas industry should consider seriously, and that the advances in the next ten years must be an endeavour to get nearer to the ideal of carbonisation, and to improve both gas and coke; and having shown you the object I have in view, let me give you my ideas as to how I think it may best be done.

The modern forerunner of the vertical continuous process was, as I have already pointed out, the Settle-Padfield retort, which I tested at Exeter seven or eight years ago, and with the principle of which I was immensely taken, and which gave splendid results. Its passage, however, from the experimental to the practical scale, as in so many cases, proved its undoing, but on looking up a notebook of that date, I find that I obtained the following results:—

Coal used—poor slack, No. 4 Cammerton.

Make per ton	Gas	13,250 cubic feet
	Illuminating power	14·72 candles (London Argand)
	Heating value	533·7 B.Th.U.
	Tar	none
Same coal in horizontal retort	Gas	9,862 cubic feet
	Illuminating power	15 candles

The Settle-Padfield process consisted of a semi-vertical or, if I may call it so, boot-shaped retort, much of the same design as now used in shale distillation. The vertical portion was about six feet in length, and the inclined part at the bottom three feet, the junction of the two portions being the weak part of the apparatus, as it was liable to crack, thus leading to infiltration of furnace gases, which was discovered when the gas given in the above test was analysed. The leak was then made good, and further tests gave 13,000 to 13,200 cubic feet per ton of 15-candle gas. The outstanding feature of the process was that the upper 3 or 4 feet of the vertical portion of the retort were left empty, and that the coal was fed in at the top by a

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plunger in charges of 2 to 7 lbs. per stroke as desired, and fell through the empty heated zone on to the red hot coke, where it was carbonised on the heated surface, the first run of rich gas rising straight up through a zone of radiant heat to the mouthpiece at the top of the retort. The weakness in this process was that the coke was allowed to accumulate, and was then at intervals removed through an ordinary oven door at the bottom of the incline, so that the " baking area " varied according to the amount of coke at the bottom of the retort. Had the retort been a plain vertical one, with an automatic coke remover working *pro rata* with the coal feed, it would have been the perfect embodiment of the true conditions for carbonisation, as the temperature needed only a little lowering in the superheating portion of the retort. The idea was to carbonise all the tar formed, so that if any condensed it was returned to the retort, and this phase of the subject is well worth discussion.

In the Settle-Padfield experimental retort, I should say, speaking from memory, that the temperature in no part of the retort was 1000° C., if so much, and yet at this temperature 13,000 cubic feet of gas per ton were made from Camerton slack, the gas tested in the London Argand giving 15 candles, which would have been 17·5 on the No. 2 Argand.

The same coal in a horizontal retort gave 9,862 cubic feet of the same candle-power gas, and ten gallons of tar per ton, so that the alteration in the method of carbonising and the tar, which if any formed was returned to the retort, gave a gain of some 3,000 cubic feet. The temperature of the lower portion, however, was insufficient to drive out all the more resistant volatile matter, and a very good coke was the result.

Now, what was it that caused that rattlejack old retort to give results better if anything than the beautiful models of constructive skill that we see in the two present continuous systems ?

In the first place, we all know the importance of a large ratio of heating surface to the mass of coal, and if you consider how the ground-up slack must have piled itself up on the top of the mass of red-hot material, heated from below, washed by the ascending hot gases from the last charge, and radiated upon by the sides of the red-hot retort above, you will see that the heating surface was far greater than in any other system, and instead of heat slowly penetrating to it, it was plunged, the moment it left the feed, into a red-hot area, which drove off a good deal of gas before even it reached the carbonising mass below, and deposited it, sweating tar, on the hot surface. The gases as they were disengaged rushed straight upwards to the exit without coming in contact with any surface to decompose them, the radiant heat being just sufficient to fix and get the best out of the tar vapour.

To many the idea of a heated space above the carbonising coal seems like going back to the lightly charged horizontal with the space that led to disaster, but they do not realise that radiant heat does little harm and much good, if there is not too much of it, and that it is contact with hot surfaces that is fatal. In the horizontal the gases rushed up to the top of the arch and were decomposed by contact, in a vertical space they rush to the cool top and exit pipe, hardly touching the sides, whilst the radiant heat performs such beneficent functions as breaking up the hexahydrides in the tar vapour into aromatic hydrocarbons and hydrogen.

Mr. W. G. Africa, in a paper read in October last at St. Louis, in relating his experience with vertical retorts, says that they got unusually high results as to candle-power by leaving a space of 4 feet of heated retort above the coal, thus fixing the vapours, which in full retorts do not reach the proper temperature for gasification.

Now, my idea of a perfect continuous system would be a vertical retort like the one that Glover first made, which had the space at the top, and fitted with a semi-intermittent feed and coke removal device, with the addition of the cooling chamber, with secondary air regeneration, the heat in the flues being concentrated on the outside of the retort at the spot where the coal falls on to the surface of the coke, as it is here that heat is withdrawn most rapidly; the temperature might then fade away above and below this area to, say, 800° C., and if properly regulated, 6 to 8 per cent. of the volatile matter of the poor gas-forming residues would be left in the coke to make a perfect domestic fuel, any shortage of gas being made up by blue water gas.

The volume of gas actually made from the coal might only be 9,500 to 10,000 cubic feet, but it would be rich in saturated hydrocarbons, and would probably stand dilution with 5,000 cubic feet of water gas to bring it down to statutory requirements.

In this way it should be possible to make more gas than at present and a valuable fuel, whilst we should have attained practically the ideal of carbonisation—uniformity.

It has always been felt by the gas engineer that tar meant a great waste of vaporised carbon, which, if it could be kept in the gaseous

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form, would give an enormous addition to the gaseous products, and would represent a large proportion of heat and light. Experiment, however, has shown that the gasification of tar and tar oil is a most thankless task to undertake, and most gas engineers look upon it from the point of view taken by Lewis T. Wright—that tar is a child of high temperature, born in the heat of the retort, and so thoroughly acclimatised as to resist all further attempts to gasify it successfully.

As regards the chief portions of high-temperature tar—pitch, naphthalene, and the higher aromatic hydrocarbons—this is true, but, as we have seen, lowering the temperature of distillation increases the yield of tar, and it seems clear that a large proportion of it is due to primary action, and consists of paraffins, naphthenes, and other hydrocarbons, which would lend themselves to gasification, as well as the oxygenated and " cycle " derivatives which are more resistant, whilst naphthalene, anthracene, etc., are absent. It is evidently worth while to see how far tar of this character can be gasified, and whether it is economically better to do this than to utilise it for other purposes.

In the early eighties Mr. Lewis T. Wright made a number of experiments on the gasification of tar and tar distillation by passing them into a retort filled with lime and heated to 1100° C., and obtained the following results:—

Tar	10,700	cubic feet	per ton of	12·5	candle-power	gas
Crude Naphtha	10,130	,,	,,	20·5	,,	,,
up to	27,000	,,	,,	14·5	,,	,,
Light Oils	18,000	,,	,,	16·0	,,	,,
up to	30,000	,,	,,	13·5	,,	,,
Creosote Oil	13,300	,,	,,	14·0	,,	,,
up to	29,300	,,	,,	8·5	,,	,,

Now, tar in those days *was* tar, and not creosote oil, pitch, naphthalene, and free carbon, and yet on these figures it was decided that tar as a source of gas was " dear at a gift," owing to the ubiquitous naphthalene obstructions and troubles that followed any attempts at gasification.

I have made many experiments upon this subject, and the conclusions to which I came long ago were that tar, once obtained in the liquid state, could be utilised for the purpose of gas-making only in one of two ways:—

1. Distil off the naphthas, light oils, etc., which come over below 240° C., and gasify these, or

2. Inject the tar into a mass of incandescent coke, so as to break it up into hydrogen and methane, having a sufficient column of red-hot coke to filter off the deposited carbon.

If the ton of coal yields 20 gallons of 1·07 of gravity tar, it is found that 25 per cent. of it will distil below 240° C., leaving a residue perfect for road-making. The 25 per cent. of distillate represents about 50 lbs. weight, and on gasification will yield 10 cubic feet per lb. of 15–16 candle-power gas; and, therefore, by this method there is obtained an addition to the gas from the ton of coal of 500 cubic feet of good lighting and heating gas and 15 gallons of good road-making tar.

If, on the other hand, the tar be returned into incandescent coke so as entirely to decompose it, the 20 gallons will yield 1,500 to 2,000 cubic feet of a mixture of hydrogen and methane with oxides of carbon, having a thermal value of between 400 and 450 B.Th.U.

Taking the tar, even of the quantity and quality yielded by such a process, no economy is to be found in converting it into gas by any other than the most simple expedients of the same character as the one utilised by Settle, of simply returning it to the retort. This applies to tar after it has been condensed, and not to nascent tar in the gaseous state as it leaves the decomposing coal.

At the beginning of the last century, when Clegg, Malam, and others had grasped the importance of preventing the degradation of the gases by contact with hot carbon, and were trying to avoid it by carbonising in thin layers, it was commonly believed that if coal were distilled in layers less than two inches in thickness, no tar was formed. This, of course, is nonsense, as anyone can see by heating a gram of coal in the bottom of a test-tube, but under the conditions of their experiments none or very little came over, and the reason is the same that led to little or no tar being found in the Settle vertical retort.

In Clegg's rotary and web retorts a thin layer of coal was passing in a tray, or on a web, through a flat oven heated to a high temperature, which gave an enormous ratio of radiant surface to the weight of coal carbonised, and under these conditions the nascent tar vapours never had a

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chance of condensing into the vesicular form found in the brown tar vapour leaving the retort; it was superheated instead of being cooled, and bore the same relation to brown tar vapour that superheated steam does to the condensing steam we see leaving the spout of a kettle. Catch it in this nascent state and heat will gasify it, but if it once cools to brown vapour, molecular condensations prevent it ever again being got in the gaseous state without almost complete decomposition, and even in the Dinsmore process, with which Mr. Carr was so enamoured, not more than 1,000 cubic feet per ton could be ascribed to its decomposition, as there was a fall in temperature before it entered the cracking duct or retort. The tar must pass direct from the coal into a temperature higher than that which gave it birth, but not hot enough to do more than gasify it, and if any important results are to be obtained from tar as a gas producer it will be on these lines, and carried out in a vertical retort, so that the radiant heat alone acts, and contact is reduced to a minimum; and this is one reason for the importance I place upon having an empty space of constant dimensions at the top of a continuously working vertical retort.

The economic advantage of gasifying tar is purely a question of the price it commands. Supposing the tar could be so gasified, and yielded 120 cubic feet of gas per gallon of 12 to 14 candle-power gas, it would not be worth more than 10*d.* per thousand in the holder, so that unless the price of tar is under a penny a gallon it would not pay to use it for this purpose.

In comparing the gas retort with the coke oven for gas-making the outstanding difference is one of heating surface, and of the size and condition of charge dealt with.

In the gas retort it is less than a ton of a fairly dry mixture of all sizes, and the thickness of the layer carbonised does not exceed 12 ins., and is generally far less, and is not compressed.

In the coke oven the charge may be anything up to 8 tons of damp, fine coal, and the thickness of the layer carbonised16 ins. to 30 ins., the charge being as far as possible compressed. Now, the important part in furnace coke-making is to provide a dense, hard coke, from which practically all volatile matter has been driven, and this means that for the full temperature of carbonisation (900 to 1000° C.) to reach the centre of the large mass of material, the time of carbonisation becomes three to five times as long as in the gas retort. Gas is evolved slowly, and therefore remains longer in contact with the red-hot coke; leakage is greater, and the ne result is that the gas yield may be averaged at 9,500 cubic feet of 10 to 12 candle-power gas, with a heating value of 540 B.Th.U.

So that it is clear that as a method of carbonisation for the production of gas it cannot compare with the retort, showing a shortage of 1,500 to 2,000 cubic feet of gas and 3 to 4 candles, whilst if, as is the usual practice, the poorer portion of the gas is used for firing the oven, the available gas amounts to only 4,500 cubic feet of 15 candle-power gas.

Now, the greatest argument which I know in favour of coke-oven gas as a town supply is that it has been adopted largely in Germany and America, neither country being open to the reproach of want of commercial shrewdness. But are the conditions under which it has been adopted the same as those existing in, say, London and Brighton? Is it not a fact that its adoption has been for areas close to colliery districts, where the conversion of smudge and smalls into coke was a necessity, in districts rich in metallurgical works, where foundry coke was a necessity; or in America, where the general use of slow-combustion stoves demands a hard, slow-burning fuel?

The claims of the coke oven as a means of making town gas are based on the economies of carbonising in bulk, and the increase in yield and value of the coke, reducing the price of the gas as made into the holder to a fraction of the 10–11*d.* a thousand it now costs; but if such a process were introduced in London, the make of coke would be enormously increased, and its quality of hardness and difficulty of burning would reduce instead of increasing the demand for domestic purposes; coke prices would fall, and the economies would be converted into a heavy loss.

At the present moment coke-oven gas is an impossibility for town supply, unless heavily benzolised, which is a mistake for a gas to be used with mantles, but under altered conditions of Parliamentary requirements it may well be that coke-oven gas will play an important part in lighting and power production in the North of England and other colliery districts; but I cannot conceive its ever being adopted where domestic fuel and not foundry coke is the chief requirement.

In a course of lectures such as these, four seems an ample allowance at the commencement and probably, to the audience, more than ample at the end; but I realise only now how miserably inadequate the time has been for the expression

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of the matter I desired to bring before you, and can only hope that some of the points, controversial though they may be, will prove helpful in considering the carbonisation of coal.

POPULATION OF FIFTEEN PRINCIPAL TOWNS OF FRANCE.

The number of inhabitants of the principal towns in France (with populations exceeding 100,000), according to the census taken on March 5th of last year, has just been published.

The following figures show the present populations of the fifteen largest towns as compared with those of 1906:—

	1911.	1906.	Increase.
Paris	2,846,986	2,763,393	83,593
Marseilles	552,182	518,498	33,684
Lyons	524,056	472,114	51,942
Bordeaux	261,678	251,947	9,731
Lille	216,806	205,602	11,204
Nantes	169,254	163,247	6,007
Nice	163,833	134,327	29,506
Toulouse	149,044	149,438	(decrease 394)
St. Etienne	148,778	146,788	1,990
Le Havre	132,667	132,430	237
Rouen	122,420	118,459	3,961
Roubaix	122,154	121,017	1,137
Nancy	118,187	110,570	7,617
Rheims	113,372	109,859	3,513
Toulon	104,582	103,540	1,042

Although in many of these places the number of inhabitants has not greatly increased, Toulouse is the only one where it is less than it was five years ago. Nice, on the other hand, shows an increase of 21·96 per cent. in the population since 1906.

COMMERCIAL FISH CULTURE IN GERMANY.

Fish-breeding in ponds is carried on in practically all parts of the German Empire, especially in Silesia, Brandenburg, Hanover, Schleswig-Holstein, Westphalia, Lorraine, the Rhine Palatinate, Bavaria, Saxony, Baden, and Würtemberg. It is estimated that the total area of fish-ponds in the empire is approximately 185,000 acres, which is about ·14 per cent. of the total land area of Germany. The size of the ponds and the average amounts invested vary greatly, depending upon the general lie and adaptability of the land on the one hand, and upon whether or not fish culture is carried on as a principal occupation or merely as a side line in connection with rural industries in which ponds are more or less necessary. The average area of the ponds ranges from 1·35 acres in Bavaria and 1·57 acres in Saxony, both of which kingdoms are rather hilly and mountainous, to 12 acres in Silesia where the land is comparatively level. There are two general systems of fish culture in Germany, one for the propagation of carp and the other for the production of trout. According to the United States Consul at Berlin, carp require warm water and are generally bred in large, shallow ponds with little inflow. The perch, American trout, tench and eel are bred under similar conditions as carp, either in ponds, together with the carp, or separately. Carp ponds are usually such as may be drained, and are either allowed to remain empty during the winter or are planted in oats, wheat, etc., or lie fallow during alternate periods of one or more years. A complete plant for the cultivation of carp usually includes a small, shallow, warm-water spawning pond, a larger so-called "nursing" or stock pond, and a fattening pond. In the nursing pond the young carp from the spawning pond are placed at the rate of 200 to 700 fish per hectare (2·47 acres) of pond area. The number depends upon the size and age of the fish on the one hand, and upon the nourishing capacity of the pond on the other. In very cold regions the carp must be taken out of the nursing ponds during the winter season and transferred to a deep specially enclosed winter pond. The carp are allowed to remain in the nursing ponds one or two summers, depending upon whether or not they are to be marketed as "three summer" or "four summer" fish. They are then placed for one or two years into the fattening pond, in which 150 to 250 fish are allowed for each hectare. To transfer the carp, the pond must be drained and the fish collected in a pit located near the outlet. Carp growing may be extensive — that is without artificial feeding—or intensive, with artificial feeding. In the latter case a pond may be stocked with two to four times as many fish, and the yield in weight in marketable fish correspondingly increased. Artificial foods that are given to carp and similar fish are maize, vetches, rice, beans, potatoes, rape-seed, meal and sesame cake, bran, cooked grains, malt, fish meal, chopped meat, snails, etc. The second general system of fish culture, the propagation of trout, is comparatively much less important in Germany. Among the 10,255 acres of ponds in Schleswig-Holstein only 294 acres are trout ponds, and in Westphalia there are 57 acres of ponds for fattening trout and 391 acres for breeding stock trout. The proportion of trout-fattening ponds in the other divisions of Germany is not known, but it is probably no larger than in the two mentioned. Unlike carp, brook and rainbow trout and similar fish require colder water, and cannot stand a temperature over 64° F. They are therefore grown in small, shaded, cold-water ponds having a considerable in and outflow. Special spawning and stock ponds are generally not maintained. The artificial foods that are given to trout are cooked shell fish, fish and slaughter-house refuse, meat of horses and other animals, and fish meal, and specially prepared fish foods. The gross and net income derived from fish culture varies on the one hand with the natural productiveness of the pond, and whether or not this is supplemented by artificial

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feeding, fertilising, etc., and on the other hand, with the cost of stocking the ponds. The profits of fish culture are also increased if the breeders can sell their product direct to the consumers. For this purpose fish-breeding associations are formed in all parts of Germany.

THE MINING INDUSTRIES OF YUNNAN.

The treasures of Yunnan lie not so much in its soil as under it. Travellers across the province have characterised it as the wealthiest district in China, but until more expert information, based upon prospecting, is at hand, judgment on this point may well be postponed. Enough is definitely known, however, to show that Yunnan has varied and valuable mineral deposits, and is entitled to the consideration of the mining world. The development of the mining industry in Yunnan has been hampered and restricted by numerous factors, among which may be mentioned an insufficient means of communication and transport, the lack of capital, and the inability of the people to co-operate in large undertakings. The development of the province will follow the development of the mines, not precede it; and the removal of the causes that have worked in the past against the opening and operation of the mines must be effected before any improvement in the mining industry may be looked for. The mining regulations reserve to the central Government 25 per cent. of the profit on all mines, plus an additional 20 per cent. in the case of precious stones, 10 per cent. in the case of gold, silver and quicksilver, and 5 per cent. in the case of coal and iron, and require all minerals to pay an export duty of 5 per cent. and a "likin" charge of 2½ per cent. The American Consul at Canton says that the tin mines of Kochin, in Mengtsz Hsien, supply between 4 and 5 per cent. of the world's production of tin. They cover an immense area and have been worked by the natives for centuries. The last decade has shown a steadily-increasing output. The mining population of Kochin, numbering about 30,000, constitutes, to all intents and purposes, a small world in itself. The right to work the mines adheres to the proprietors of the land, who can exercise it themselves or lease it. These rights are clung to with great tenacity. The whole industry is regulated by a committee of all the mine owners, which in mining affairs exercises an autocratic jurisdiction, and the miners, smelters, porters, etc., are combined in guilds of their own with full power over their members. The deposits occur both on the surface and beneath it, but surface mining has now been abandoned. The shafts are sunk in the hillsides at an angle usually of 45°, and are started at random, without previous test borings. The ore is for the most part ferruginous, with a slight tracing of lead. One British analyst found 50 per cent. of hematite and magnetite. Many of the shafts reach a depth of over half a mile, but from their horizontal direction require no ore-lifting apparatus. The shafts are, without exception, extraordinarily narrow and low, the roomiest in the whole district is only four feet high and a little over three feet wide. For miners, half-grown boys are in demand, as their greater agility and smaller stature are an advantage in these narrow galleries. The majority of the miners succumb at an early age to the unhealthy conditions which surround their labours. In some of the shafts an awkward attempt has been made to assist the circulation of the air by means of "wind boxes," or bellows, but even in these the atmosphere is foul and unwholesome. As a rule the ore is broken up at the mine's mouth and cleaned, and when it has reached a point where it contains 60 per cent. of tin, it is carried in baskets to the smelting ovens. There are some thirty of these ovens in Kochin, imperfectly constructed of clay bricks, at a cost of about £200 each. The bellows used are of wood, and each requires three men to work it. Ten men in all are required for each oven. The ovens are fired in November, and continued in use for three months. Charcoal is used for fuel. When the metal first flows with the slag into the retainer it is so impure that repeated recastings are necessary. It is not known how much metal is lost in the smelting process, but it is probably not less than 20 per cent. It has been stated that one oven will turn out between 1,500 and 1,700 pounds of tin a day, but these figures are, if anything, too low.

The process of refining cannot be carried on in Kochin to a very fine point, and when the slabs are placed on the market they still contain an appreciable quantity of other substances, principally iron and lead, which makes re-smelting necessary before pure metal is obtained. For many years the mines of Kochin have supplied the demand in China for tin for use in the national coinage, in the manufacture of "silver joss" paper burned at religious ceremonies, and in other industries. The recent substitution of silver dollars and fractional pieces and copper cents for the old-time brass "cash" has diminished the home demand for the metal, and a large share of the output of the mines now finds its way to foreign markets. The exportation of Kochin tin is controlled by the merchants of Mengtsz, who ship principally to their correspondents in Hong Kong. During the last few years a proposal to introduce foreign machinery has been discussed by the mine owners, but no decision has been arrived at. The extensive orpiment mines in Mengkwa and the Chaochow, are rich in ore. Coal is distributed throughout nearly the whole province. Copper, silver and lead have been mined by the natives for years in the north-east, and iron, zinc and quicksilver in other districts. The northern part of Yunnan is rich in salt wells, and supplies the principal demand for this commodity. The existence of gold has been inferred from the name Chin-sha Kiang, or River of Golden Sand, which the Yangtze bears in its course through north-western Yunnan, but the presence of gold deposits has not been definitely established.

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THE PRODUCTION OF BALSAM OF PERU.

Balsam of Peru really comes from the Republic of Salvador, and the tree is found on the coast which extends along the western Pacific slope of Salvador between the ports of Acajutla and La Libertad, a distance of only about forty miles. Assuming that this strip has a depth from the coast of fifteen miles, there is an area of only seven hundred and fifty square miles at the most over which the tree is exploited. Balsam from Salvador has been called Peruvian for the following reason: The Republic of Salvador has a coast-line on the Pacific Ocean only, and from its ports must therefore be shipped all its products. If they go across the Isthmus of Panama, as has been the case for three hundred years and more, these shipments are confused with those from Peru in South America, hence balsam from Salvador was called Peruvian. The balsam tree is one of the most beautiful of a tropical forest. The trunk is cylindrical, the bark somewhat cracked, of a greyish or ashen colour, with whitish blotches due to the parasitic lichen that clings to it. The fruit is a pale, yellow, membranous, feathery pod, with only one seed as a rule. According to a report of the International Union of American Republics, balsam collecting is a very interesting work. Although the tree holds sap (*jugo*) at all seasons of the year, yet it becomes more abundant according as the season is dry, and consequently the summer is selected as the most favourable time for securing the crop (*cosecha* as it is called). The entire process, from collecting the crude sap to its final storage in metal cases for shipment abroad, is not all in the hands of one individual, but divides itself, like rubber gathering, into two procedures. When the dry season is assured, the gatherer selects his tree, and at the period of the young moon gets it ready. He first strikes or scratches the bark with a stone or other blunt instrument, girdling it in a peculiar fashion of his own. The bruise thus made is intended to detach the outer bark, but to leave the second, inner layer exposed. The hole thus made in the bark is called the window. From this tender portion of the tree there exudes, after a variable period of from five to eight days, the mature sap of the tree. The most popular method of obtaining the sap is to attach to the wound or "window" a piece of cloth of a size sufficient to cover it, and sufficiently absorbent to become impregnated completely with balsam. The cloth must be extremely clean, or otherwise the flow will not be steady, and the dirt on the cloth will make the further process an uneven one. At the end of eight to ten days, according to the weather, the flow ceases, and it must be again stimulated by a second irritation. This is accomplished by applying heat to the tree by means of a burning torch. Great skill is necessary in using this heat, to get just the right effect, for if the torch is applied too closely the balsam catches fire. Heat is applied every two months, and after each stimulus of this kind five or six cloths (*trapos*) are changed. A final collection of sap is obtained in some cases by scraping the wound and the various strata of bark down to the inner wood, and, after reducing this bark to a powder, boiling out the residue in water. A trick of the trade is the adulteration of the crude balsam by mixing with it an amount of raw sugar, or the charred husks of cacao diluted in water. The life of the balsam tree is about one hundred years. The gathering of sap is begun at the age of twenty-five years, and this sap may be gathered indefinitely, unless some accident to the tree occurs meanwhile. When the sap has been collected from one tree or a dozen of them, the pieces of cloth are loosened and at once placed in a kettle of water, in which they are boiled for half an hour. The pieces are then immediately, while quite hot, thrown into a primitive kind of press composed of a small-meshed net of coarse cord or braid in endless folds. As the cloths are squeezed, the sap exudes and settles to the bottom of the kettle beneath; the liquor on the top can then be poured off, and what is called crude balsam alone remains. The unclarified balsam is put in a vat beneath which a slow fire is kept burning. As the viscous liquid is warmed, the water is driven off by evaporation, and the organic impurities gather gradually on the surface. After the clarification is completed, the liquid is poured into rectangular tins, each containing about fifty-five pounds of balsam, and shipped as the well-known article of commerce to its European or American destination.

A GERMAN TREE-FELLING MACHINE.

A machine for felling trees has been invented in Berlin. The principle of the invention is that by pulling an ordinary steel wire rapidly backwards and forwards around the tree to be felled, sufficient heat is developed by the friction to burn a smooth groove through the stem of the tree. The American Consul-General in Berlin says that the inventor illustrates his invention by means of an ordinary steel wire about a yard in length, which is provided with a single handgrip at each end, which he pulls rapidly backwards and forwards around a chair or table leg, the wire thus burning a groove into the wood. In actual tree-cutting a smooth tensely-drawn steel wire, having a diameter of ·039 to ·118 inch and a length of about twice the diameter of the tree, is placed round the stem where the cut is to be made, and is fastened at each end by means of easily manipulated clasps to the two ends of a long steel cable or hawser leading to the readily transportable electric power machine. In the case of the harder wood varieties a wire with side projections is substituted for ordinary smooth wire, and in some cases a cable of two or more wires is used. Each of the two ends of the power cable or hawser passes, at the machine

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end, through eyes in each end of a double-armed lever, from where they are brought together and passed through the hollow shaft in the centre of the lever, after which they are wound up together upon a pulley or windlass with a crank. In this way any slack in the cable may be taken up and the tension of the wire in cutting may be regulated. The double-armed lever of the power machine is driven backwards and forwards upon its central shaft by means of a driving rod from an eccentric wheel which rotates by motor power. The power cable and the wire are thus pulled backwards and forwards at the rate of 16·4 feet per second. In cutting down trees the cable is chosen long enough to make it possible to place the machine out of reach of the falling tree. The machines may also be used in cutting logs or timber already felled, in which case a shorter cable may be used. The power required for European varieties of wood ranges from 1·5 to 7 horse-power, depending upon the hardness and dimensions of the timber. A 4 horse-power machine is said to cut down a pine tree two feet in diameter in about five minutes. The Consul says that although the inventor has made demonstrations before the Government forestry and other officials, the authorities and timber interests have not as yet generally taken up the invention. Objections raised to the system are that it is expensive, and that with the occasional breaking of the wire and other delays no time is saved in the long run. Another objection is that, although it does cut down trees, the plane of the cut is never exactly straight, and the burning so chars the wood that the age circles as well as any knots and other defects are not easily distinguishable. On the other hand it is claimed that by washing the ends of the timber the rings, etc., may be readily made visible, and the charring and burning are said to preserve the wood where the cut is made.

HOME INDUSTRIES.

Miners and the Minimum Wage.—There is grave reason to fear that the miners are bent upon striking, and that there will be a two-thirds majority at the ballot in favour of a national stoppage. The men seem to be spoiling for a fight, and the employers are no longer disposed to make concessions, for they feel that they are fighting for the principle of the sanctity of agreement. They contend that the South Wales agreement of 1910, signed by them and the men, has three years to run, and prevents any such demand as that of the men being made now. The demand for the minimum wage did not become part of the definitely accepted policy of the Miners' Federation until the autumn of 1909, and in the opinion of many of the employers its acceptance would be a staggering blow to the coal trade. There are many estimates of the extent to which the output would be reduced, and some experts put it at not less than 20 per cent. Assuming it to be only 10 per cent., its effect upon the export trade must be very serious. And the minimum wage asked for, 8*s.* a day, is considerably more than the wage now earned at a majority of the collieries in Great Britain. Coming on the top of the burdens imposed by the Mines Regulation Act, and the Insurance Act, the enforcement of the minimum wage might well give our foreign competitors in the coal market an advantage that would be disastrous to much of our export coal trade. The output of coal in Germany and the United States is rapidly increasing, and their export trade with it, whereas we exported less last year than in any year since 1906. The loss of any considerable portion of our coal exports would mean enormous loss, directly and indirectly, to the country, and those who suffered most would be the miners themselves, for many collieries would be closed, and the men who cannot or will not earn the minimum wage would be dispensed with. It may be hoped that these considerations will ultimately weigh with the men sufficiently to induce them to abstain from a strike that would be disastrous to all concerned, but at the moment there is scant ground for hope.

The Cotton Position.—Messrs. Hubbard Brothers and Co. refer to the lock-out in the Lancashire cotton trade as a cause of the check in the foreign demand for cotton and the relapse in prices. They hold, however, that the determining influence was the unwillingness of spinners and "investors" to follow the advance from the lowest point beyond a given limit. "It is," they say, "a question this season of spinners providing themselves with a reserve supply out of the largest American crop ever grown. Cotton will be bought to take the place of the shortage in the India crop and in the yield of other countries, but the surplus will have to be carried by merchants and by spinners. A very large quantity will be carried against sales for forward delivery because the European spinners are willing to take a view of the situation for a longer time than for one season, utilising directly and indirectly the future markets for that purpose. Our own Northern mills have so far taken from this crop less cotton than last season; we do not hear of any who are acting upon the broad view of the Continental spinner and seeking to provide on the present comparatively low range of prices for cotton ahead. They appear to be waiting for that sharp decline which they have been expecting after the European had secured his supplies upon which to buy, but did not expect, nor in fact did anybody believe, that these foreign spinners would think of securing cotton for several years in advance because it was below the average price of the past five years. We see the extent of this forward demand in the premium paid for new-crop deliveries, when they usually sell at a discount at this season of the year. There is a better tone to the cotton goods business in America, which may be the forerunner of a demand to replenish exhausted stocks in the hands of retailers. Certainly, the fashions can only change in such a manner as to call for an increased consumption of cotton cloth."

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Shipbuilding.—The year 1911 was a record year in Scotch shipbuilding. The statistics collected by the *Glasgow Herald* are very remarkable. They show that the tonnage output of all the Scotch yards last year was 357 vessels of 671,624 tons and 837,668 i.h.p. engine-power. The proportions of the several rivers were: Clyde, 413 vessels and 630,583 tons; Forth, 31 vessels and 11,319 tons; Tay, 31 vessels and 17,303 tons; and the Dee and the ports of the Moray Firth, 82 vessels (of the fishing type) and 12,419 tons. The Forth was about 2,000 tons, and the Tay about 12,000 tons up, but the Dee and the North were practically unchanged. The Scotch production made a gain in the year of no less than 257 vessels, aggregating 251,374 tons and 213,400 i.h.p. The mere increase in Scotland was more than the entire year's output of any country in Europe except Germany, and was almost equal to the entire output of the United States. These are interesting facts which illustrate the extraordinary character of the year. The Clyde output alone—that is, tonnage launched, which does not mean, of course, vessels completed—of 630,583 tons and 789,929 i.h.p., that is to say, the entire output as distinct from the increase, was in tonnage more than half as much again as the entire output of Germany and equal to the entire production of the rest of Europe. The Clyde production last year was only 30,000 tons less than the combined output of the United States and Germany, and it is 10,664 tons and 221,402 i.h.p. more than the previous record year, 1907. With the exception of Barrow, Liverpool, Middlesbrough and Stockton, all the principal shipbuilding centres share in the advance, and how greatly the United Kingdom is in advance of other shipbuilding countries is shown by the following comparison of the latest returns as to new construction (including sailers) recorded at Lloyd's:—

	Ships.	Tonnage.
United Kingdom	483	1,519,000
Germany	89	350,300
France	26	123,000
United States	59	105,800
Holland	45	79,700
Austria	11	62,100
Japan	35	22,000
Norway	43	21,700
Denmark	12	19,200
Italy	18	19,100
Belgium	6	14,200

Thus, the United Kingdom tonnage is more than four times that of Germany, while it only lacks 42,000 to make up the double of the tonnage of all the other countries combined.

The Port of Manchester.—Although during the second six months of 1911 the Manchester Canal suffered from serious and prolonged labour troubles —which led to sheds and quays being blocked with cargo which could not be got rid of because of the disorganisation of inland transit, and since then some of the railway companies have been unable to find railway waggons in sufficient numbers to clear the docks of the merchandise ordered forward by rail, with the result that much trade has been lost to the port through the inability to provide discharging berths, and the handling of the cargo has been done in circumstances which must seriously prejudice the financial result of the year just ended—the gross receipts of the Canal show some increase upon those of 1910, a little over £570,000 as compared with £555,735, and if the net revenue of the year shows little or no improvement, the check was due to special causes which have passed, and there is ground for the expectation that, given the absence of labour troubles, 1912 will show considerable improvement. The various regular steamship services of the port, both foreign and coastwise, have been well maintained during the year, and both importers and exporters are becoming more and more convinced that it is to their interest to use the Ship Canal. The quantity of foreign grain which arrived in Manchester during 1911 constitutes a new record, and the returns show an increase of about 45,000 tons over the figures of 1910, about 493,000 tons having been imported via the Canal. Of this, it may be interesting to note that about 131,425 tons come from India, 124,995 from Russia and the Black Sea ports, and 117,106 from the United States and Canada.

The Clothing Trade.—It is believed that the output in the wholesale clothing trade last year was the largest upon record. A feature of the year's trade has been the demand for measured goods, in itself a proof of the widespread prosperity of the working classes in 1911. When wages are low and irregular the demand is for the cheapest clothing that can be produced; when wages are high and steady the demand is for good clothing, as has been the case this year. The clothing industry is mainly a home trade, but during the past year shipments to South Africa, which is the chief oversea market, increased, and orders coming through at present are larger than they have been for some time past. The only thing likely to interfere with the prosperity of the trade in the current year would be a strike on a serious scale, for the clothing trade is the first to suffer and the last to recover from the effects of labour disputes.

Small Holdings.—It is pleasant to read of the success of the Small Holdings Act where it has been worked by a local authority in sympathy with its aims, and it has been possible to get suitable land. The new President of the Board of Agriculture has been visiting the estate purchased by the Northumberland County Council from Lord Ridley for the purposes of the Act. It contains 871 acres of arable land, and about twelve under wood, and the average annual rental is about 34*s*. per acre. The tenants speak very hopefully of their prospects, and there are nearly 400 applicants still waiting for land. The county council could absorb 20,000 acres if they could get them, and many of the

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actual tenants are earning a livelihood out of land which was previously practically derelict. In another part of the county, an estate is in occupation of small holders, many of whom are miners who work the regulation eight hours in the pits, and give the remainder of the day to the cultivation of land and the breeding of stock. Labour underground seems to give the colliers added zest for farming operations. It must, of course, be remembered that the Northumberland men are some of the pick of their class, but the evidence accumulates that in all parts of the country workers are anxious to benefit by the Act, and that where men can get suitable land on reasonable conditions they are doing well upon it.

CORRESPONDENCE.

THE FISHERIES OF BENGAL.

I have read, with much interest, the remarks of Mr. Frank Birdwood on the above subject in the *Journal* of the 5th inst. The reason why the "Golden Crown" experiments were inconclusive is to be sought for in the policy of the official who succeeded Sir Krishna Gupta as "Commissioner of Fisheries." Not only were the "Golden Crown" results vitiated, but other investigations, such as the "Culture of Carp," the Sunderbuns survey, and the study of the spawning grounds of the Hilsa, were also, to a large extent, interfered with. What Mr. Wilmot Corfield said in the *Journal* of the 29th December, about the neglect of the "Golden Crown" fish after landing at Calcutta, is, unfortunately, too true.

At this time of day it would serve no useful purpose to enter into matters with which personal considerations are concerned. I can only reiterate that, in my opinion, a well-managed fishery company, to supply the Calcutta and other markets with fresh fish in ice, would be a profitable concern. It will give the speediest return on the smallest capital. If, afterwards, such matters as a cured-fish trade, or even steam trawling in the open sea be taken up, well and good; but allow me to advise, in the first instance, a cautious and careful consideration of the hundred-and-one factors which make for success in a large fishery company.

JAMES TRAVIS JENKINS.

NOTES ON BOOKS.

SOAP BUBBLES. By C. V. Boys, F.R.S. New and enlarged edition. London: Society for Promoting Christian Knowledge. 3*s*.

The large audiences of "Juveniles" of all ages, who have been listening to the lectures which Mr. Boys has just been giving at the Royal Society of Arts, and watching with delight his very beautiful experiments, will be glad to learn that they can obtain in a handy and inexpensive form a somewhat fuller account of soap bubbles, their colours, and the forces which mould them, than it is possible to give in the course of a couple of lectures. The book is written in the simplest style, so that a child of fourteen or fifteen, of ordinary intelligence, could easily understand it, and the apparatus for the experiments described is of a corresponding simplicity, nothing being required in many cases but a few pieces of glass and india-rubber tubing. It is, perhaps, hardly to be expected that the young physicists, however conscientiously they may follow the minute and practical directions in the volume, will achieve that wonderful success in conducting experiments which gives to Mr. Boys the appearance of a magician; but, without arriving at this degree of perfection, they may well find some pretty amusement for the holidays, while the charm of the subject may awaken some to the interest of a more prolonged and serious study of science.

The first edition of this book appeared about twenty years ago. The second and enlarged edition differs from the first in the addition to the old text of the description of further experiments and observations on the subjects there treated. There are, besides, five additional chapters on "The Soap Bubble," "Bubbles other than Soap Bubbles," "Composite Bubbles," "Out-of-door Bubbles," and "The Colour and Thickness of Soap Bubbles." The last is necessarily somewhat difficult, as the theory is given very fully and exactly, but without the use of algebra or trigonometry. The genesis of the colours is illustrated by means of a coloured plate, which also is stamped on the front cover. The chapter on "Out-of-door Bubbles" shows how pleasing an occupation may be derived from the use of soap bubbles in a garden on a summer day. This probably will be found the most interesting addition to the non-technical reader.

GENERAL NOTES.

LECTURES ON ILLUMINATING ENGINEERING.—A course of ten lectures on Illuminating Engineering will be given at the Northampton Polytechnic Institute on Tuesday evenings at 7.30 p.m., commencing January 16th, 1912. The lectures are intended for a technical audience, and each lecture will be given by a specialist in the particular subject. The subjects and lecturers are:—(1) "The Nature of Light and of Radiation," by S. D. Chalmers, M.A.; (2) "Photometry and the Measurement of Light," by A. C. Jolley; (3) and (4) "The Production of Electric Light and its Distribution," by F. M. Denton, A.M.I.E.E.; (5) "The Chemistry of Gas Manufacture and Lighting," by S. Field, A.R.C.S.; (6) "The Use of Shades and Reflectors," by S. D. Chalmers, M.A.; (7) "Physiological Factors in Illumination," by W. Ettles, M.D.; (8) "The Practical Use of Arc Lamps," by A. C. Plumtree; (9) "The Practical Use of Metallic Filament Glow

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Lamps," by Val. H. Mackinney; (10) "The Practical Use of Gas Lamps," by W. E. Goodenough. The course is regarded by the Governing Body as a pioneer course; should it be as successful as its importance warrants, it will in subsequent sessions be developed into full special courses, including laboratory and other important ancillary work. It is intended for engineers, architects, medical men, representatives of public bodies, and administrators generally, as well as for general technological students of engineering. Full particulars of the course can be obtained on application to R. Mullineux Walmsley, D.Sc., Principal, Northampton Polytechnic Institute.

Bryan Donkin Fund. — The second triennial award of grants in aid of original research in mechanical engineering, under the Bryan Donkin Fund, will be made in February, 1913, when the amount available will be about £34. Applications should be made to the Secretary, Institution of Mechanical Engineers, Storey's Gate, S.W.

An Ordnance Survey for Tripoli. — A geographical mission to Tripoli, under the auspices of the Italian Government, has been organised by the Instituto Geografico of Florence. The expedition is under the command of Colonel Caputo, of the Staff Corps, and formerly professor at the School of War. Besides the necessary geodetic operations for the completion and revision of the existing maps of the country, it is intended to establish an astronomical observatory at Tripoli. It is also intended to fix the trigonometrical stations, which will eventually serve as bases for the triangulation of the country, the surveys of which will be made on the scales of one to 100,000 (·63 inches to a mile), and one to 50,000 (1·26 inches to a mile), the same as those of the ordnance survey of Italy.

Cattle-Rearing in Japan.—The statistics lately published by the Japanese Government tend to show that the rearing of cattle in that country is in a flourishing condition. The number of head of horned cattle, which was 1,261,000 in 1900, had increased to 1,297,000 in 1908, and to 1,350,000 in 1909. Horses, which numbered 1,542,600 in 1900, and dropped to 1,367,000 in 1905, on account of losses during 1905, had more than regained the former figure, and were 1,551,000 in 1909. The number of sheep in Japan is quite insignificant, and were only 2,400 in 1900 and 3,400 in 1909. The number of goats increased from 60,000 in 1900 to 87,000 in 1909. Pigs increased from 181,000 to 287,000 during the same period. The number of animals slaughtered for food in 1909 was as follows: cattle 178,000, horses 45,000, sheep and goats 7,000, pigs 161,000. The Japanese Government, with a view to encouraging the improvement of the breeds of cattle, etc., have established three model farms and a poultry farm. There are, besides, three establishments for the breeding of horses and stallions.

Platinum Production in New South Wales.—Although not one of the chief mineral products of New South Wales, platinum is found in paying quantities. It has been mined in the central part of the State, and the beach sands on the north coast have been treated for the metal. Up to the end of 1909 the total Commonwealth production was only 11,578 ounces, valued at £21,000, and nearly the whole of it was contributed by New South Wales. In 1910, 332 ounces, valued at £1,380, were won in New South Wales. For some years the price of the metal abroad has been rising, until at the end of June, 1911, it had attained the record price of £9 per ounce. This high price will probably lead prospectors in New South Wales to investigate more carefully the possibilities of platinum mining.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 17. — Cyril Davenport, F.S.A., "Illuminated MSS." Sir Walter Armstrong, Director of the National Gallery of Ireland, will preside.

January 24.—William J. Gee, "Hydraulic Separating and Grading." Robert Kaye Gray, M.Inst.C.E., will preside.

January 31. — Professor G. W. Osborn Howe, "Recent Progress in Radio-Telegraphy." Sir William H. White, K.C.B., F.R.S., will preside.

February 7.—Leonard Hill, M.B., F.R.S., and Martin Flack, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

February 14.—Cecil Thomas, "Gem Engraving." Sir Arthur John Evans, D.Litt., LL.D., F.R.S., will preside.

February 21.—Frank Warner, "Silk." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

February 28.—H. A. Roberts, M.A., "The Relations of Science to Commerce and Industry." Principal Sir Henry A. Miers, M.A., D.Sc., F.R.S., will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

January 18.—The Rev. Walter K. Firminger, B.D., Senior Chaplain, Bengal Establishment, "The Old District Records of Bengal." Sir James A. Bourdillon, K.C.S.I., will preside.

February 8. — Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India."

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MARCH 14.—E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

APRIL 25.—WALTER SAISE, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

MAY 16.—NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock :—

JANUARY 30.—W. A. LEGG, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony, "Irrigation in South Africa." The HON. SIR RICHARD SOLOMON, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, will preside.

MARCH 26.—R. H. BARRAUT, Resident at Jesselton, "British North Borneo."

MAY 7.—ALAN BURGOYNE, M.P., "Colonial Vine Culture."

MAY 21.—THE HON. J. G. JENKINS, "Australian Railways."

CANTOR LECTURES.

Monday evenings, at 8 o'clock :—

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." Two Lectures.

Syllabus.

LECTURE I.—JANUARY 22.—The size and speed of ocean waves—The height of waves in lakes, seas, and rivers—The length of waves in lakes, seas, and rivers—The steepness of waves, and strains upon ships—The periodic time of waves, and the rolling of ships—The speed of waves and its relation to velocity of wind—The height of waves and its relation to velocity of wind—The time required to develop large waves, and the duration of storms—The length and speed of the swell observed after storms—The probable height of the swell during storms—The relation between the dimensions and path of a cyclonic depression and the nature of the winds produced—The depth in which waves break, and its relation to defence works.

LECTURE II.—JANUARY 29. — The action of waves and tidal currents on sea-beaches and sandbanks—The proper action of waves to drive sand and shingle shoreward—The proper action of waves to drive mud seaward—Special conditions under which the action on sand is reversed—The proper action of the tide to drive shingle in the direction of the flood—The normal removal of shingle from promontories and its accumulation in bays—The exceptional accumulation of shingle in salient positions, *e.g.*, at Dungeness—Groynes—The reason of the graded arrangement of shingle on the Chesil beach—The formation of a sandbank on the up-channel side of a promontory—Sandbanks in estuaries and their arrangement by tidal currents—Their rippled surface as a means of mapping these currents—Their influence on the formation of tidal bores—The struggle between land water and tidal water to arrange the sandbanks in the Severn—The variability of the Severn Bore as determined by these factors—The circumstances which determine the starting point of the Severn Bore.

LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock :—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced :—

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

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MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 15...Bibliographical, 20, Hanover-square, W., 5 p.m. Annual Meeting. Presidential Address by Mr. H. B. Wheatley.

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. H. E. Field, "Fire Protection at a London Brewery."

Economics, London School of, Clare Market, W.C., 8.30 p.m. Sir Clement Kinloch-Cooke, "Emigration."

Surveyors, 12, Great George-street, S.W., 7 p.m. (Junior Meeting.) Mr. E. H. Blake, "Mortgages."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. Archibald Rose, "The Chinese Frontier of India."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. M. M. Pattison Muir, "Alchemy."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. E. F. Strange, "Alfred Stevens."

TUESDAY, JANUARY 16...Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Professor S. J. Chapman and Mr. F. J. Marquis, "The Recruiting of the Employing Classes from the Ranks of the Operatives in the Cotton Industry."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. T. E. Ritchie, "Colour Discrimination by Artificial Light."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Papers: 1. Mr. S. H. Ellis, "Reinforced-Concrete Wharves and Warehouses at Lower Pootung, Shanghai." 2. Mr. W. C. Popplewell, "The Direct Experimental Determination of the Stresses in the Steel and in the Concrete of Reinforced-Concrete Columns." 3. Mr. W. H. Burr, "Composite Columns of Concrete and Steel."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. J. W. Gordon, "A Speculum Condenser."

WEDNESDAY, JANUARY 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Cyril Davenport, "Illuminated Manuscripts."

Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m. Anniversary.

Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Annual Meeting. 2. Presentation of the Symons' Gold Medal to Professor Cleveland Abbe. 3. Address by Dr. H. N. Dickson (President), on "Some Meteorological Observations."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 10.30 a.m. 1. Professor Dr. C. A. F. Benedicks, "A Metallographic Hygroscope." 2. Dr. G. D. Bengough, "A Study of the Properties of Alloys at High Temperatures." 3. Professor H. C. H. Carpenter, "Further Experiments on the Inversion at 470° C. in Copper-Zinc Alloys." 4. Mr. R. H. Greaves, "The Influence of Oxygen on Copper containing Arsenic or Antimony." 5. Mr. F. Johnson, "The Influence of Tin and Lead on the Micro-structure of Brass." 6. Mr. Arnold Philip, "A Contribution to the History of Corrosion: the Corrosion of Condenser Tubes by Contact with Electro-Negative Substances." 7. Dr. W. Rosenhain, "The Nomenclature of Alloys." 8. Professor T. Turner, "The Behaviour of Certain Alloys when Heated in Vacuo."

Microscopical, 20, Hanover-square, W., 8 p.m. Address by the President, on "Certain Blood Parasites."

United Service Institution, Whitehall, S.W., 4 p.m. Earl Fortescue, "The Immediate Requirements of the Territorial Force, with special reference to Recruiting."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Professor W. L. Courtney, "Dramatic Literature."

THURSDAY, JANUARY 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Rev. Walter K. Firminger, "The Old District Records of Bengal" (to be read by the Rev. J. A. V. Magee).

Geographical, Burlington-gardens, W., 5 p.m. (Research Meeting.) Dr. J. S. Owens, "The Settlement of Sediment in Running Water."

Royal, Burlington House, W., 4 30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. Dr. A. Anstruther Lawson, "Some Features of the Marine Flora of St. Andrews."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. C. T. Heycock and F. E. E. Lamplough, "Boiling Points of Mercury, Cadmium, Zinc, Potassium and Sodium." 2. Mr. J. F. Thorpe, "Formation and Reactions of Imino-compounds. Part XVII.—The Alkylation of Imino-Compounds." 3. Messrs. W. H. Perkin, W. M. Roberts and R. Robinson, "1:2-Diketohydrindene." 4. Messrs. E. G. Jones, W. H. Perkin and R. Robinson, "Isonarcotine." 5. Mr. J. J. Sudborough and Miss M. K. Turner, "Esterification Constants of some Substituted Acetic and Benzoic Acids." 6. Mr. P. May, "Aromatic Antimony Compounds. Part III.—Primary Aryl Derivatives."

China Society, Caxton Hall, Westminster, S.W., 8.30 p.m. Staff-Surgeon W. P. Yetts, "Symbolism in Chinese Art."

London Institution, Finsbury-circus, E.C., 6 p.m. Rev. A. S. Palmer, "Literary Blunders."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. W. Bickerton, "The New Astronomy." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. E. Collins, "Holidays among Sea-Fowl."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Discussion on Mr. A. H. Seabrook's paper, "Residence Tariffs."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. H. Jenkinson, "The Records of the Royal African Company."

Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m. 1. Mr. F. Reed, "A Submerged Flexible-Joint Main." 2. Mr. C. Brackenbury, "Unwatering Tresavean Mine." 3. Mr. H. M. Morgans, "Notes on the Operation of Two Winding Engines." 4. Mr. C. P. C. Sullivan, "Stoping at the Calamon Mine."

Economics, London School of, Clare Market, W.C., 5 p.m. Dr. T. Farkas de Boldogfa, "The Constitutional Law of Hungary."

FRIDAY, JANUARY 19...Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir James Dewar, "Heat Problems."

North-East Coast Institute of Engineers and Shipbuilders, Bolbec Hall, Newcastle-on-Tyne, 7.30 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. G. Ingram, "The Turbo-Blower and Turbo-Compressor."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.30 p.m. Sir George Greenhill, "The Sighting of Small Arms and Artillery."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Dr. Edward Hopkinson and Mr. Alan E. L. Chorlton, "The Evolution and Present Development of the Turbine-Pump."

SATURDAY, JANUARY 20...Royal Institution, Albemarle-street, W., 3 p.m. Rev. John Roscoe, "The Banyoro; a Pastoral People of Uganda. I.—The Milk Customs."

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Journal of the Royal Society of Arts.

No. 3,087. VOL. LX.

FRIDAY, JANUARY 19, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 22nd, 8 p.m. (Cantor Lecture.) VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." (Lecture I.)

WEDNESDAY, JANUARY 24th, 8 p.m. (Ordinary Meeting.) WILLIAM J. GEE, "A New Process for Hydraulic Separating and Grading." ROBERT KAYE GRAY, M.Inst.C.E., will preside.

Further details of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, January 18th; SIR KRISHNA GOVINDA GUPTA, K.C.S.I., in the chair. A paper on "The Old District Records of Bengal," by the REV. WALTER K. FIRMINGER, B.D., Senior Chaplain, H.M.'s Bengal Establishment, was read by the REV. J. A. V. MAGEE, M.A.

The paper and discussion will be published in a subsequent number of the *Journal.*

THE ROYAL SOCIETY OF ARTS.*

By SIR HENRY TRUEMAN WOOD, M.A.,
Secretary of the Society.

VI.—THE PREMIUMS.
(1754–1851.)

Continued.

In the first twenty years or so of its existence, down to 1776, the Society expended a little over £1,500 in premiums connected with the manufacture of textiles—part in establishing, or attempting to establish, new branches of the industry, part in endeavouring to improve textile machinery. With regard to the latter part of the work, it is easy to see, after a century's experience, that they were working on wrong lines; but that is merely to say that the members of the Society who directed its proceedings were no wiser (or not much wiser) than their contemporaries. They took immense pains to improve existing apparatus, instead of—as if they had been gifted with sufficient prophetic insight they might have done—anticipating the slow course of inventive progress, by encouraging the production of new methods. It is reasonable to wish they had been more enterprising; it is unreasonable to blame them for their lack of non-existent knowledge. *Ex post facto* criticism of the sort is as foolish as it is easy.

The Society's treatment of the important question of spinning mechanism is a good case in point, and it is very clearly stated by Dossie.* At the time when he was writing (1768) a certain amount of progress had been made in the construction of spinning machinery. Just thirty years before (1738) Paul and Wyatt's machine for "spinning by rollers" had been patented, and soon after the patent was granted the apparatus was in successful operation.† Yet Dossie, with full knowledge of the facts, gives his deliberate and reasoned opinion in favour of improving the ordinary spinning-wheel.

"I am authorised," he says, "to give this judgment on the principle of spinning by mechanism instead of the hand, from my own observations, as well as those of two other very judicious members of the Society, who were best acquainted with that matter, in the spinning machine invented by the late Mr. Paul, which carried this application of mechanics to the greatest extent it is perhaps capable of. By a very great expence, and the assistance of the most ingenious theoretic, as well as practical, mechanicians of our time, he attained to the construction of a machine, that being moved by

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, November 3rd, 1911, and January 12th, 1912.

* Vol. I. p. 93.

† "Industrial England in the Middle of the Eighteenth Century," p. 53.

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water, horses, or any other power, would spin, in the most perfect manner, any number of threads, without other assistance of the hand, than to supply the carded cotton, take away the finished roll of thread, and rectify any accidental disorders of the operation. But the delicacy of the work of the machine, equal almost to that of clocks, which subjected it to be easily disordered, and at the same time so expensive to be repaired, and the peculiar manner of carding, which was likewise very expensive, have occasioned this machine to be wholly laid aside as unprofitable, after sixty or seventy thousand pounds have been spent in various attempts to establish its use."

Now these remarks are perfectly sensible, and it was in consequence of the ideas and opinions that they embody that the attention of the Society was devoted to the improvement of the spinning-wheel. Various prizes were offered, and certain small improvements were duly rewarded. None of them, however, were of any great value, and, as we fully recognise now, the efforts of the Society were quite futile, and its energy was entirely misdirected. Hargreaves had already (1764) invented his "Jenny," and Arkwright had patented (1769) his "water-frame," while a little later (1780 or thereabouts) Crompton brought out his "mule." One wishes that those three names were to be found in the Society's lists, instead of three of the improvers of the venerable spinning-wheel, who were duly rewarded.

A good many rewards for improvements in the loom were made at different times by the Society.* In 1764 a prize of £100 was offered for improvements in the stocking-frame, and in the minutes of 1765 is an interesting description of the competition, for which a large number of persons entered. These were set up in the "machine-room," and a number of expert workmen were employed to test them. After a careful examination, the full prize was awarded to one of them, and this was supplemented by an amount subscribed by a number of manufacturers. This encouragement to British stocking weavers was of special value, because the manufacture was in a depressed condition at the time, and suffering severely from competition with the better productions of French looms.

The premium lists contain mention of occasional awards down to the year 1830, and amongst these were some for improvements of considerable value. Porter, writing in 1831,* refers to the improvements in silk weaving which had been rewarded by the Society, which he says, "has done more for the encouragement of ingenious artisans in this branch of industry than has been, or than could be, effected by the patent laws under the present system." Amongst these may be noted the improvements in the "drawboy" for which a prize was awarded in 1807 to A. Duff. The mechanical drawboy was invented by Joseph Mason, to whom, in 1687, a patent was granted for "weaveing such stuffes as the greatest trade in Norwich now doth depend upon, without the helpe of a draught-boy." Before his invention the cords of the loom, which had to be drawn in a prearranged succession in order to produce the pattern, had to be pulled down by a boy who stood at the side of the loom and used a large fork and lever for the purpose. When a mechanical device was substituted for the boy who acted as the weaver's assistant, the apparatus took its name from the original worker whom it replaced.

The actual invention of the drawboy has erroneously been attributed to Duff, but what he did was to introduce very considerable improvements. He himself, in his paper in the *Transactions*, disclaims novelty for his invention, which he describes as an improvement on methods previously known. Three years later, in 1810, J. Sholl was rewarded for further improvements on Duff's apparatus.† A little later still came the great invention of Jacquard, on which various improvements in details were made by English inventors. Some of these were rewarded by the Society, the most important of these being the invention of W. Jennings, a weaver or loom-maker of Bethnal Green, who reduced the great height of the Jacquard apparatus, and thereby rendered it available for use in the rooms in which the silk weavers then generally worked.‡

The manufacture of silk in England had been firmly established by the two great immigrations of Flemish weavers in the sixteenth century and of Huguenots in the seventeenth. Mills for "throwing" silk had also been set up in the eighteenth century. But the various attempts which had been made to produce silk in this country had all failed. The success of

* A very full account of the Society's relations with John Kay, the inventor of the fly-shuttle, was given in the *Journal* of December 8th, 1911, so there is no need to refer to them in the present article.

* "Silk Manufacture" (Lardner's Cabinet Cyclopædia).

† *Transactions*, Vol. XXV. p. 51 (1807), and XXVIII. p. 123 (1810).

‡ Porter, p. 253. *Transactions*, Vol. XLVIII. p. 175.

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Louis XIV.'s great minister, Colbert, in establishing the production of silk in France aroused emulation over here, but without practical result. James I., whose efforts to encourage English manufactures perhaps deserve more credit than they have received, tried to acclimatise the silkworm, and for this purpose he had mulberry trees planted in St. James's Park on the site of the present Buckingham Palace. The experiment was continued for some time, since it is recorded that in 1628, Charles I. appointed Lord Aston keeper of "His Majesty's mulberry garden at St. James's, and of the silkworms and houses thereunto appertaining"; but the garden, as far as its original object was concerned, proved a failure, and turned into a place of public entertainment. A scheme started in 1718 had no better success. Large plantations were laid out in Chelsea, but after a short trial, the project collapsed. Dossie, in two letters which he wrote (under the signature of "Agricola") to the *Museum Rusticum* in 1766,* relates how a person, whose name is not given, sent some specimens of English-grown silk to the Society in that year, and how the Society, not considering his silk deserving any serious reward, yet encouraged him by the gift of a reel and basin such as were used by the silk-growers of Piedmont.† This seems to have been one of several attempts to grow silk in this country at the time, for some small prizes were awarded in 1763 and in 1778 for raising and winding silk. The Society seems to have held the view that the production of silk in England was not practicable, and while it took a good deal of trouble to promote silk-growing in the American colonies, it did nothing at first to encourage it in Great Britain. The specimens, however, abovementioned drew fresh attention to the matter, and Dossie rather vigorously combated the received opinion, urging that further experiments should be made. Accordingly, in 1768, a prize for English-raised silk was offered, and from time to time after this date, efforts were made to encourage the planting of mulberry trees and the raising of silk-worms. The Hon. Daines Barrington contributed a paper to the second volume of the *Transactions* on the subject, and in it he also urged the advantage of silk-growing in England, and gave some information as to the practice in the East and on the Continent. The Society continued to offer rewards for the plantation of mulberry trees, and for the production of silk, with the result that from time to time small quantities of cocoons were produced, but the matter never got beyond the experimental stage, where indeed it now remains. Some years later, in 1825, a vigorous attempt was made to raise silk here on a commercial scale, and a company with a large capital was started. It, however, was unsuccessful, and though even later proposals have been put forward for the plantation of mulberry trees and the raising of silkworms, they have never led to any practical result. In 1840, W. Felkin, of Nottingham, sent the Society some samples of British-grown silk, and was formally thanked for them, and in 1873 Sir Daniel Cooper produced some similar experimental specimens. The latest communication on the subject to the Society is a paper read in 1877 by Mr. Francis Cobb, in which the writer recommended the raising in England of silkworm "grain," or eggs, for exportation abroad. The reason generally put forward for the failure has been the lack of cheap labour, but whatever the cause, the fact remains that while it has been shown that perfectly good silk can be produced in this country, nobody has ever succeeded in producing it in profitable quantities.

At various times attempts were made to encourage the production of lace in England. The first award was taken in 1762 by Dorothy Holt, who made the ruffles worn by George III. at his coronation. Several other small prizes were given about the same time, but the matter dropped, and though some years later the offer of prizes was renewed, nothing very much came of it. Lace making was one of the very few domestic industries which survived, and perhaps it neither needed nor profited by artificial stimulation.

Between the years 1861 and 1865 the amount of £410 was expended in rewards for what was known as "quilting in the loom," that is to say, weaving fabrics having a diagonal pattern like a quilt. Such fabrics were imported from the East, and "Indian quilting" was much admired, as appears from occasional references in contemporary literature. Some, perhaps all, of the material was hand-made. It was not, however, produced in England, till the Society, in 1761, offered a prize for "a quantity of quilting, made in a loom in imitation of, and nearest in goodness to, the Marseilles or India quilting." In successive years samples of a gradually

* *Museum Rusticum*, Vol. VI. pp. 89 and 241.

† It appears from the minutes that the correspondent wrote under an assumed name, "Rusticus," but it seems, from a note by Dr. Templeman on one of his letters, that he was really John Delamare, a member of the Society and a silk manufacturer of Spitalfields.

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improving character were produced in silk, cotton, linen and wool, until in 1765 the committee on Manufactures reported that "the manufacture appears to be sufficiently established," and the prizes were discontinued.

The writer of the "Observations on the Effects of Rewards" in the class of manufactures, appended to the list of awards published in 1778, writes in a very jubilant strain about the result of these particular prizes, for he says:—

"The manufacture is now so thoroughly established and so extensive, being wrought in all the different materials of Linen, Woollen, Cotton and Silk, that there are few persons of any rank, condition or sex in the kingdom (and we may add within the extent of British commerce, so greatly is it exported), who do not use it in some part of their clothing; so that we may safely say, if the whole fund and revenue of the Society had been given to obtain this one article of trade, the national gain in return should be considered as very cheaply purchased."

In the first half of the eighteenth century a number of factories had been started in England by Walloon, Flemish and French weavers for the manufacture of tapestry and pile carpets, apparently with but moderate success.* The subject was one to which a good deal of attention was paid by the Society, and premiums were given in 1757 to Moore, of Chiswell Street, and to Whitty, of Axminster, in 1758 to Passavent, of Exeter, and in 1759 to Jeffer, of Frome. It seems probable that Passavent's factory was the one founded about three years earlier, and mentioned by Johnson's friend, Baretti, two years later (1760).

By these awards, it is stated,† the manufacture of carpets "is now established in different parts of the kingdom and brought to a degree of elegance and beauty which the Turkey carpets never attained."

The drugget, for the manufacture of which a prize was offered in 1758, was not the floorcloth now known by that name, but a "sort of stuff very thin and narrow, usually all wool and sometimes half-wool and half-silk." ‡ It was used as a material for clothing, and as late as 1832 Bulwer Lytton describes one of the characters in his "Eugene Aram" as wearing a "spencer of light brown drugget." There was a great demand for it in the Lisbon market, and this market was mainly supplied from France, so it was thought that there was a good opening for British trade. Various awards were made during the next four years, and satisfactory samples were produced, but "owing to exterior circumstances attending the course of our trade with Portugal," the importation to Lisbon was never established. Dossie, who reports the matter, comforts himself with the philosophical reflection that if such a branch of the woollen manufacture had been established it would only have come into competition with branches already existing.

In 1809 the Society made the following award:—

"To the Patrons and Committee of the Flag Association, for a matchless specimen of double brocade-weaving in a flag now executing in Spital-fields, the silver medal set in a broad gold border."

A full account of this flag is given in a curious and rather interesting pamphlet which has been preserved in the Guildhall Library.*

It appears that Sholl and some other journeymen weavers formed a committee to produce some work which would afford proof of the capacity of British workmen to manufacture something as good as any foreign work. With this object they collected subscriptions to defray the cost of weaving a very elaborate flag. They collected over £570, but when the flag was finished they found themselves in debt for £380 more. The flag was exhibited at the Society's distribution of prizes in 1811, when the medal was presented, the flag being then finished. It seems by the description to have been a very remarkable piece of work, and from the terms of the award it was evidently highly approved by the committee. Its after history is not known, Sholl's work having been published in 1811.

About the end of the eighteenth century the idea of making fishing-nets by machinery seems to have attracted some attention both in France and in England. The Société pour l'Encouragement de l'Industrie Nationale (founded in 1801) offered a prize of 10,000 francs, a part of which (according to the "Encyclopædia Britannica") was awarded to Jacquard. In 1771 the Society of Arts offered a prize of twenty guineas for a similar object. Awards were made in 1776, 1796, and 1806, and the two machines (by Boswell, of Barnstaple, and Robertson, of Edinburgh), for

* A good summary account of these is given in the latest (eleventh) edition of the "Encyclopædia Britannica," in the article on carpets by Mr. Alan Cole. The history in the earlier editions is neither full nor accurate.

† *Transactions*, Vol. I. (1783) p. 28.

‡ "Chambers's Cyclopædia" (1751).

* "Short Historical Account of the Silk Manufacture in England." By Samuel Sholl (1811).

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which the last two awards were made, look from the descriptions as if they would have worked well enough, but the above quoted authority states that the first efficient machine was by Paterson, of Musselburgh (the date of which was about 1820). The devices of some of these net-making machines were afterwards embodied in some of the later lace-making machines.*

What is now termed "Industrial Hygiene" was amongst the first subjects to which attention was given—that is to say, methods of preventing injury to workmen engaged in dangerous or unhealthy occupations, or proposals for the substitution of innocuous substances for those in the preparation or use of which there was risk of injury to life or health.

The late Mr. Benjamin Shaw, therefore, when in 1876 he founded a prize for inventions devised to minimise the risks incidental to industrial occupations, was only carrying out a very old tradition of the Society.

The first prize of the sort was offered in 1771, for any means of lessening the injurious effects of the process of fire-gilding or water-gilding, as it was sometimes called. In this process a coating of an amalgam of gold and mercury is applied to the metallic surface to be gilt. The mercury is volatilised by heat, and the gold is left as a thin adherent film. The process has now been to a large extent superseded by electro-plating; but it is still used for fine work, as it gives a very good solid deposit. The mercurial vapours given off are, however, extremely injurious to the operator, and before proper appliances were devised to carry them away, the early workers suffered severely from them. The offer produced an apparatus intended to remedy the objections, and in 1774 a prize of twenty guineas was awarded to its inventor (J. Hills), who kept a curiosity shop in Berwick Street. According to the description of Dossie † who (like the present writer) found Hills's own description unintelligible, the apparatus consisted of a funnel fixed in front of the furnace and over the article under treatment. This funnel was connected by a pipe to the furnace chimney, and a draught produced by a bellows drew up the fumes and discharged them into the flue. If necessary, glass screens could be added, with openings through which the workman could pass his hands, enclosed in leather gauntlets. After inspecting a model, the Society's committee ordered a full-sized apparatus to be constructed and set up. A "Mr. Platts, a workman in the water-gilding way," was engaged to work it. "A day being fixed, several members of the Society went to see its effect, and reported that they had not felt any of the so-called sweet vapour during the operation." Having thus assured themselves, by personal immunity from mercury poisoning, of the value of the apparatus, they decided to award Mr. Hills the offered prize. A little later Platts wrote that he had made use of the apparatus "ever since the trial." He added, "I ... wish I had been so happy as to have had the use of such an invention twenty years ago; I make no doubt but that I should have been free from the disorder I have so long laboured under."

The actual process of fire-gilding is practically identical now with that seen by the Society's committee in 1774, and a certain amount of risk is still run by the workman. But he works under very much better sanitary conditions, and he has the advantage of various appliances, such as india-rubber gloves, unknown to his predecessors of a hundred and fifty years ago.

Forty years later we find the same grievances existing, and a fresh attempt made to remedy them. In 1811 a prize of twenty guineas was awarded to Richard Bridgen for "a method to prevent the inhalation of noxious vapours in gilding metals." This time it was a mask to be fitted over the workman's nose and mouth, and connected to a tube, which was led to the back of the head, so that the air breathed was not charged with the fumes immediately proceeding from the heated metal. If preferred, the tube might be lengthened and led to a window, so as to provide communication with the external air. That the device was quite practical and effective, though decidedly inconvenient, may be admitted as certain. That it is still regarded in some quarters as a novelty is shown by the fact that when, eight years ago, in 1903, a special prize was offered by the Society for a dust-arresting respirator, several masks, identical in principle with Bridgen's, were submitted in competition.

A considerable further advance was made by John Roberts, who, in 1825, received a silver medal and fifty guineas for "apparatus to enable persons to breathe in thick smoke, or in air loaded with suffocating vapours." This apparatus would appear to be the original of the various modern devices, firemen's helmets, respirators and the like, used—or proposed—for enabling persons to breathe in smoke or noxious atmospheres. It consisted of a leather

* Felkin's "History of the Machine-wrought Hosiery and Lace Manufacture" (1867), p. 156.

† Dossie, Vol. III. p. 370.

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helmet, padded so as to fit airtight to the wearer's neck and shoulders, and fitted with glass or mica eye-pieces. From the front of the helmet was suspended a flexible leather tube, with a helical wire inside, and terminating in a trumpet-shaped mouth. The object of this was to draw the air for respiration from near the floor level, where there was less smoke. The trumpet was filled with moist sponge covered with coarse cloth. For convenience, the pipe was strapped to the wearer's thigh. If the cloth was sufficiently porous, this must have been a very efficient and practical appliance. It is evident that the pipe was an unnecessary detail, and might have been dispensed with. Roberts's apparatus was carefully tested by the Society's committee, and was found to work very well, according to the account given in the *Transactions.** He himself was a working collier of St. Helens.

Considerable public attention was drawn a little later still (in 1830) to the Chevalier Aldini's† wire-gauze mask ‡ or screen for the use of firemen, and the Society gave him a gold medal, with the remark: "Something is still wanting to give to his ingenuity all the practical utility of which it is capable; and it is in the hope of this being effected that the Society again call to it the public attention." §

The dangers to health from many dusty trades, in which the harm is done by mechanical particles breathed by the workman, was not overlooked, and in 1805 a gold medal was offered for "obviating the prejudicial effects that attend the operation of pointing needles by grinding them dry, during which the particles of grindstone dust and steel, being thrown into the air, and received with it into the lungs, occasion asthma, consumption, and other painful disorders." The offer was afterwards extended to include other processes of dry grinding, and was continued for twenty years. In ordinary grinding work with a wet stone, the stone cuts more quickly, because the water washes away the metallic particles and fine dust, so that the grain of the stone is not, as the grinders say, "choked," but the dry stone, though it cuts more slowly, leaves a finer surface, and therefore has always been used for needle-pointing and for similar work.*

Of the various appliances submitted, some of which received rewards, the best was that of J. H. Abraham, of Sheffield, to whom, in 1822, the Society awarded its gold medal for a magnetic guard to protect persons employed in dry grinding. The apparatus is described in the *Transactions.*† The stone is enclosed in a wooden casing, so that only a portion is exposed, and the current of air generated by its revolution carries the dust into a tube, by which it is led away. The invention also includes a respirator to cover the mouth and nose. This respirator was fitted with magnets, for the purpose of arresting the fine particles of steel thrown off in the process of pointing needles, and in other processes of dry grinding. Although the invention was greatly appreciated at the time, and was actually brought into practical use, it never became popular, the main objection to it having been raised by the workpeople themselves, who feared that the lessened risk attached to their employment would lower their wages. Similar considerations have always stood in the way of the introduction of various appliances intended to limit the risks associated with all trades in which the workpeople breathe a dusty atmosphere.

The question of producing a lead glaze for pottery, which would be effective without affecting the health of those employed in the manufacture, is a very old and a very important one, and one that has not yet been solved. At a very early date it came before the Society, and in 1793 a prize of a gold medal was offered for "glazing earthenware without lead."

As is well known, the glaze on earthenware is merely a thin coating of glass, or silicate of soda. On many of the coarser forms of pottery, the glaze may consist of pure silicate of soda, and may be obtained by the use of common salt. But such a glaze is only applicable to clay bodies, which will stand a very high temperature—a class which includes a very large number of the roughest sorts of pottery, and also what is known as stoneware. By the use of lead a very much more fusible glaze is obtained, and this is available for all the more delicate kinds of porcelain and other more easily fusible ware.

The offer, in 1793, induced an application from one Law, who submitted specimens of an "East Indian material called by him 'She Kaw.'"

* *Transactions*, Vol. XLIII. p. 25.

† Giovanni Aldini (1762-1834) was an Italian physicist of some distinction, and Professor of Physics at Bologna.

‡ In 1827 a reward of five guineas had been paid to J. Callaghan for a wire-gauze "face-guard for smelters." This was intended merely to protect the face from heat, but it might have been applied to other purposes. (*Transactions*, Vol. XLV. p. 152.)

§ *Transactions*, Vol. XLVIII. p. 141.

* Holtzapffel, "Mechanical Manipulation," Vol. III (1850) p. 1111.

† Vol. XL. (1822) p. 135.

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Samples were submitted to Thomas Wedgwood for report, and he reported adversely on the material, which proved to be some sort of selenite.

For many years the offer was continued without any result, until 1820, when a claim was made by John Rose, of Coalport. "The principal ingredient of my glaze," he wrote, "is felspar of a somewhat compact texture, and a pale flesh-red colour, which forms veins in a slaty rock adjoining to the town of Welsh Pool, in Montgomeryshire. This material, being freed from all adhering pieces of slate and of quartz, is ground to a fine powder, and being thus prepared, I mix with 27 parts of felspar, 18 of borax, 4 of Lynn sand, 3 of nitre, 3 of soda, and 3 of Cornwall china clay. This mixture is to be melted to a frit, and is then to be ground to a fine powder, 3 parts of calcined borax being added previously to the grinding." This was perhaps the first of the many felspathic glazes which have been suggested as substitutes for lead glaze. It was, no doubt, an excellent glaze, and probably well deserved the gold medal which was awarded to Mr. Rose for his invention. Two years later, in 1822, another premium was awarded to J. Meigh, of Shelton, Staffordshire, for another felspathic glaze.

The offer of the prize was continued for another two years, and in the meantime arsenic had been added to the prohibited ingredients. But after 1823 the premium was discontinued.

As is well known, the problem has not yet been satisfactorily solved. As late as 1910 a Departmental Committee reported on the dangers attendant on the use of lead in the manufacture of earthenware and china, and this report contains the fullest and latest information on the subject of leadless glazes. Many such glazes have been added to that of John Rose, but none of them are so effective as, and all of them are more expensive than, a glaze in which lead forms a part. Very great improvements have naturally been made in the manufacture, and to a very large extent the desired end has been attained by the method of preparing the lead glaze, which is now made of a much less soluble character than of old, so that the processes of manufacture are much less dangerous to the workmen. By such means, and by insisting upon proper sanitary precautions, the death-rate has been so largely reduced that practically the object sought for has been attained without the necessity for prohibiting methods of earthenware-making, which, whatever might be their result upon the health of the workers, would only, in the opinion of those best qualified to judge, have the result of driving the manufacture of high-class ware out of the country, and of placing it in the hands of foreigners.

Until quite the end of the eighteenth century, chimneys were always swept by climbing boys, and nobody seemed to see any hardship in this occupation for children. Even so kindly a soul as Charles Lamb, in his essay on chimney-sweeps, ignores the enormous amount of brutality and cruelty which fell to the lot of "those tender novices, blooming through their first nigritude." Mrs. Montague, the celebrated "blue-stocking," gave the climbing boys an annual dinner, and so, if Elia is to be believed, did his old school-fellow, James White. But the first to make a serious effort to improve their condition appears to have been Jonas Hanway, who was instrumental in introducing into Parliament the Bill which was passed in 1788. This Act (28 George III. c. 48) imposed certain restrictions on the business, but, on the whole, was ineffective.

In 1796 the Society offered a prize for an apparatus for "obviating the necessity of children being employed within flues." A note to this announcement refers to the great hardships endured by, and to the frequent fatal accidents occurring to, the children employed. The prize offered was a gold medal or forty guineas. This prize was renewed at intervals up to 1803. Various proposals were submitted, including a machine by G. M. Smart, but no awards were made before 1805, when Smart sent in an improved machine, and to this the prize was awarded. This apparatus was practically the same as that which is now used —namely, a number of rods connected together, and carrying a brush at the top. In Smart's apparatus the rods were hollow; they fitted one into the other by means of sockets or screws, and were all held together by a cord running through them. This machine was afterwards known as the "scandiscope," and soon came into general use.* According to a note in the *Transactions*, Smart had given up his own profitable business from philanthropic motives, and devoted himself to the invention and popularisation of chimney-sweeping apparatus.

* A great deal of information about the climbing-boys and the reform which led to their suppression will be found in Mayhew's "London Labour and the London Poor" (edition of 1861), Vol. II. p. 399. Howe, in his "Everyday Book," Vol. II. p. 518, also gives many curious and interesting details, including a quaint advertisement of the scandiscope.

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In the year 1800 the Society for Improving the Condition of the Poor took up the subject, and in 1803 a special society was formed for superseding climbing-boys. The treasurer of this society at one time was William Tooke, a vice-president of the Society of Arts, who many years later, on the death of the Prince Consort in 1862, held the presidency of the Society for a year until the election of the then Prince of Wales (King Edward VII.). It was due to the exertions of Mr. Tooke, and to the appeal of Mr. J. J. Angerstein, the well-known philanthropist, that the Society of Arts associated itself with the newly-formed society, and renewed its offer of prizes for machines for sweeping chimneys. In 1817 a Parliamentary inquiry was held, at which Tooke, Smart, and others gave evidence, and this led to the passing of a second Act in 1834 (4 & 5 Will. IV. c. 35). Eventually a third Act (3 & 4 Vict. c. 85) was passed in 1840. This came into force in 1842, and at last put an end to the use of climbing-boys.

After the award to Smart various other prizes were given for other chimney-sweeping machines, including some in which the brush was dragged through the flues by means of a rope. But none of these seem to have come into use in this country, although the rope machine is extensively employed in France.

Considering that the foundations on which the science of chemistry was eventually built were only laid in the last years of the eighteenth century, it is obvious that such industries of a chemical nature as existed could only be of a purely empirical character, and were not really conducted on scientific principles at all. Some progress, it is true, had been made in technical chemistry abroad,* but in England there had been but little advance. Indeed, it was the discovery by Leblanc, in 1792, of the method of making carbonate of soda from common salt that really formed the basis of modern industrial chemistry, since it provided a cheap source of alkali, previously only obtainable from vegetable ashes as an impure carbonate of potash and soda, or in the form of salpetre (nitrate of potash), either native or artificial. In an early premium list (1770) is included a prize for barilla,† "made from Spanish kali, raised in Great Britain." The offer was continued for thirty years, but produced no results, nor was a similar offer for barilla grown in any British possession more effective, though the barilla industry was an important one in India, and Dr. Roxburgh, the great Indian botanist, who died in 1815, reported that one species of *Salicornia*, abundant on the Coromandel coast, might yield barilla sufficient to make soap and glass for the whole world. No better result was obtained by a similar prize offered for British grown kelp, richer in alkali than the ordinary sort.

Later on (1783) the true way of supplying the demand for alkali was suggested in the offer of a prize for obtaining soda from sea-salt, a problem which, after exercising the minds of many chemists and inventors (among the most notable of these was Roebuck, the friend of Watt and Priestley, who ruined himself in the attempt), was eventually solved by Leblanc, in response to a prize offered, not by the Society of Arts or any other society, but by the Emperor Napoleon.

The Society's efforts to increase the supplies of saltpetre or "fossil fixt alkali" have already been referred to in the article dealing with the Colonies.* An attempt was also made to establish works for the production of saltpetre in England, but the only result of these efforts was to demonstrate the impracticability of manufacturing it on a commercial scale at a price which would compete with that of imported saltpetre, and, after a few years, the attempt was abandoned.

Rewards were also offered for the production of borax, sal-ammoniac, bismuth, and some other materials in Great Britain, but naturally without more result. Somewhat better fortune attended an effort to establish in England the manufacture of verdigris (basic acetate of copper), used as a pigment and a dye, and then imported from France, where it was made by treating copper-plates with wine-lees.† In this country the necessary vegetable acid was obtained by using the pulp of apples from cider-presses, and other fruit-juice. By the offer of liberal and continued grants, the industry was actually started, and a considerable amount of the material was produced, but no regular manufacture was established.

One of the two first prizes offered by the Society was for English cobalt, the object being the production of smalt and zaffre, both silicates

* Sir Edward Thorpe, in his "History of Chemistry" (1909), gives the names of Gahn, Marggraf, Duhamel, Réaumur, Macquer, Kunkel and Hellot as the pioneer technical chemists of the eighteenth century.

† Barilla was the ash of plants of the genus *Salicornia* or glasswort. It contained only about a fourth of its weight of carbonate of soda.

* *Journal*, September 29th, 1911.

† The chief seat of the manufacture is still Montpellier, in France.

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of cobalt, associated with silicate of potash, and made by melting the oxide of cobalt with sand and potassium carbonate. The glasses thus obtained form useful blue colouring matters. The first offer (1754) produced some samples, and an award of £50 was paid for cobalt from a Cornish mine in 1755. Nine years later, a similar sum was granted to Nicholas Crispe, the watchmaker, one of the founders of the Society, for making zaffre and smalt. Again, in 1810, the attempt was renewed, but without practical result.

Among the earliest objects to which attention was directed was the improvement of methods of dyeing textiles, wool, silk and cotton, and the encouragement of the domestic production of the materials (mainly vegetable) which were then employed. England was much behind other countries in its methods of dyeing and calico-printing (as it was in most other industrial processes) when the Society was founded, and much of the cloth woven here had to be sent abroad to be dyed, as much of the linen had to be sent abroad to be bleached. The very first prize offered by the Society was for a dyeing material, madder, and this was followed by others for dyeing cloth, silk, linen and cotton, sometimes of specified colours, and sometimes by improved or cheaper methods, or by materials not previously used. The Society worked hard for twenty years to establish the cultivation of madder in England, and by 1775 it had expended a sum of £1,516 in the effort. After the first two or three years, it paid a definite amount of £5 per acre of madder grown annually, and these payments varied from £5 for a single acre up to, in one exceptional case, £145. After 1775 the rewards were discontinued, the Society's object having so far been attained that the price of imported madder was reduced, and its quality improved, by the competition of the home-grown product. It is also recorded that the Society was instrumental in obtaining an Act of Parliament, which modified the amount of tithe levied on crops of so costly a nature as madder.*

Numerous rewards were offered for the importation of new or little known dye-stuffs from the colonies, and some rather unavailing efforts were made to start in England the growth of tinctorial plants more suited for other climates. Such, for instance, were the orchella weed (*Rocella tinctoria*), a lichen native to many parts of the world and producing the colouring matter archil, or orchil, long used for dyeing red and purple; and, even a less reasonable proposal, indigo. A premium for growing the former in Great Britain was offered in 1763, and a similar offer was published in 1817 with reference to indigo. A suggestion in 1763 as to the employment of Prussian blue (sesqui-ferrocyanide of iron) may be noted. The material was known at the time, but appears not to have been used as a dye.

Besides thus endeavouring to add to the list of materials available for the dyer, the Society included in its premium list the production of new or improved colouring matter for use as pigments. Amongst these perhaps the most important was a substitute for white lead. For over fifty years from 1788, when it was first offered, a prize for a "substance for the basis of paint" "equally proper for the purpose as the white lead now employed," appeared in the premium list. The value of the prize was at first £30, but it was afterwards raised to 100 guineas. That the prize was never awarded is not perhaps very remarkable, since it is only of quite recent years that even a partial substitute for white lead (a basic carbonate of lead) has been found in zinc-white (zinc oxide), and even this, though it is non-poisonous and is unaffected by atmospheric influences, does not combine with the oil of the paint as effectively as the lead, while the paint has less "covering power," and is more costly.

In the first printed list of premiums is a prize for improved varnish, and from time to time prizes were offered for varnishes, materials for varnish-making, methods of bleaching lac, etc. Although some small rewards were given, the offers appear to have had no practical result until 1833, when a gold medal was presented to J. Wilson Neil for a paper on the art of making copal and spirit varnishes. Until the publication of this memoir, varnish-making had always been professedly a trade secret, and the methods of its manufacture were jealously concealed. Mr. Neil, however, who was a varnish-maker of great experience and of considerable reputation, put an end to this state of things by giving full and copious details of all the methods and materials employed. His paper, which occupies fifty-five pages in Vol. XLIX. of the *Transactions* (1831-3), pp. 33–87, was for long the principal, if not the sole, source of information on the subject, and though its contents have often been republished, it remains to the present day a valuable treatise on the manufacture, and may still be consulted with advantage.

* Dossie, Vol. I. p. 42.

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At a time when oil was the chief source of illumination, and vegetable oils were scarce and expensive, many attempts were made to get rid of the fœtid smell of the train oil which was for many purposes, on account of its cheapness, the only sort available. A very early prize was offered by the Society (in 1757) for the "edulcoration" of oil. According to Dossie,* the result can hardly be considered to have been satisfactory, for when samples of the "edulcorated" oil were compared with some of the same oil before treatment, "it was difficult to say which was the worst. For the operation had added an empyreumatic smell to the putrid fœtor which was very little diminished." Dossie, however, can hardly be considered an impartial critic, for he afterwards (1761) produced a process of his own, for which the Society gave him £100. His process consisted in treating the oil with chalk or lime, and adding either common salt or potash. It was said to have been very successful.†

A good example of the results of the efforts of the Society to introduce new medicinal plants is afforded by the introduction of rhubarb (*Rheum palmatum*) into Great Britain. In 1763, the Society appointed a Committee "to pursue the requisite measures for introducing the culture of the true rhubarb," and eventually a gold medal was offered.

The Committee obtained specimens of the plants and roots from various sources, but were doubtful if they had got hold of the genuine rhubarb, until they found that Dr. Mounsey, an English physician settled in Russia, had, at the suggestion of Sir Alexander Dick, President of the Royal College of Physicians of Edinburgh, sent over some seeds of the plant, which had been planted by various persons in England and Scotland. Dr. Hope, the Professor of Botany at Edinburgh, had raised some plants, others had been "raised in the garden of the Museum in London." Accordingly, in 1769, gold medals were awarded to Dr. Mounsey for introducing the seed, to James Inglish for raising plants from it,‡ and seven years later (1776) Sir A. Dick was awarded a gold medal, and Mr. Callendar, of Newcastle, a silver one. The Society still continued its rewards in order to secure the growth of the plant on a commercial scale, and during the following twenty years various medals were given, amongst others a silver medal, in 1789, and a gold one, in 1794, to William Hayward, of Banbury, which town became, and still remains, the principal seat of the industry in England.

* Vol. I. p. 188.

† Dossie's paper was published in full, some time after the author's death, in the *Transactions*, Vol. XX. (1802) p. 209.

‡ A full account of the history of the introduction of rhubarb is given in Dossie, Vol. II. p. 258, and in Vol. III. p. 208, there is a very interesting letter from Sir A. Dick.

Another medicinal plant, the growth of which it was attempted to encourage, was opium. In 1796, John Ball, of Williton, Somerset, sent to the Society some samples of home-grown opium, and, as on examination the drug proved to be of good character, a "bounty" of fifty guineas was presented to him. Full details of his method of growing the poppies and of obtaining the extract were supplied by Mr. Ball,* who wrote enthusiastically about the prospects of his crop, and said that he expected to be able to dispose of all that he could grow to a London druggist at the price which foreign opium then fetched, viz., twenty-two shillings a pound.

In the premium list for the following year, 1797, gold and silver medals were offered for specified amounts of British-grown opium, and this offer was continued for some time, though without much response. In 1800, the larger prize was awarded to Thomas Jones, who for some years had grown opium at Enfield and elsewhere.† Though he says he found more difficulties than Mr. Ball had reported, and had suffered in some years from unfavourable weather, he had produced considerable amounts of saleable opium, which was reported upon as equal to the best Turkey. It was concluded that the possibility of producing the drug commercially in England had been demonstrated.

After an interval of nearly twenty years, yet another gold medal was awarded, in 1819, to John Young, an Edinburgh surgeon, who had successfully grown opium in Scotland. He, like his two predecessors, contributed a very full and interesting paper to the *Transactions*,‡ and he writes as if he had had some experience of Indian opium-growing. He states that he had obtained 56 lbs. of opium from an acre of ground, which, at 36*s.* per pound (the London price at that time), would bring in a little over £100. The total net profits per acre are estimated at £110 7*s.* 6*d.* It was therefore demonstrated that opium, as rich in morphia as the eastern product, can be grown in Great Britain, but it is one of those crops which requires an abundance of cheap labour, and probably for that reason its cultivation has never been permanently established here.

* *Transactions*, Vol. XIV. p. 253.

† *Ibid.*, Vol. XVIII. p. 161.

‡ *Ibid.*, Vol. XXXVII. p. 23.

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In 1801 a gold medal was offered for the production of artificial ultramarine. The offer was continued for a good many years, and in the list for 1812 a note was added that "it appears from the analysis of lapis lazuli by Klaproth, and the experiments of Guyton (related in the 'Annales de Chemie'), that ultramarine is a blue sulphuret of iron, and that a blue substance much resembling it is constantly found amongst the scoriæ of blast furnaces where iron is reduced." Nobody was found, however, to act on the suggestion. Foreign chemists were more enterprising, for after Tassaer in 1814 observed the spontaneous formation of a blue compound in the soda furnaces at St. Gobain, the Société pour l'Encouragement offered a prize for an artificial ultramarine. Ultimately the problem was solved by Guimet and by Gmelin, the latter of whom was then at Tübingen, and an industry was started which still flourishes in Germany. The material is a silicate of alumina and iron, together with iron sulphide. The manufacture has never been established in this country.

In 1821, a gold medal was offered for a test for arsenic, and the offer was continued for six years without result. Fifteen years later, however, it produced a communication from James Marsh, the well-known chemist of Woolwich Arsenal, and to him the medal was awarded, in 1836, for the test since known by his name. Marsh's test for arsenic is described in all chemical text-books, and is familiar to all chemists. It is only necessary to say that the description given in the *Transactions** holds good to-day. The test is one of extraordinary delicacy, and the cautions given by the inventor as to the need for special care in securing the purity of the reagents employed are as necessary now as when they were written.

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

Wednesday, January 17th, 1912; Sir Walter Armstrong in the chair.

The following candidates were proposed for election as members of the Society:—

Aiyar, Palayam Rajam Sesha, B.A., 10, Kuppumuthu-street, Mount-road, Madras, India.

Baker, Asa George, Messrs. G. & C. Merriam Company, Springfield, Massachusetts, U.S.A.

Barbour, James Foster, Maysville, Kentucky, U.S.A.

Bowles, George Vernon, c/o Messrs. Read Brothers, Ltd., Kentish Town, N.W.

Butt-Gow, H. F. S., Laimakuri, Dibrugarh P.O., Upper Assam, India.

Crouch, Vernon Foster, J.P., c/o Chief Native Commissioner, Salisbury, South Rhodesia, South Africa.

Durrant, Hubert Arthur, Hunstanton, Norfolk.

Eberle, Professor Eugene G., Ph.G., A.M., Dallas, Texas, U.S.A.

Fuchs, Ernest, Box 334, Guadalajara, Mexico.

Gibbs, Eustace L., Tyntesfield, Flax Bourton, Somerset.

Harkness, William Young, Lago Vista, Negritos Payta, Peru, South America.

Hughes, Vivian Arthur Beesley, Ellerslie, Grassfield-avenue, The Cliff, Manchester.

Langton, John James Perez, 421, South Seventh-street, St. Louis, Missouri, U.S.A.

Leitner, Henry, The Leitner Electrical Company, 7, Prince's-street, Westminster, S.W.

Ripper, Charles, 7, Laurel Bank, Lancaster.

Scotland, Alexander Paterson, Keetmanshoop, German South-west Africa.

Sen, Diwan Mangal, Gujranwala, Punjab, India.

Spence, David, Ph.D., F.I.C., The Diamond Rubber Company, Akron, Ohio, U.S.A.

Windass, John, F.S.A.M., The Hall, Osbaldwick, York.

The following candidates were balloted for and duly elected members of the Society:—

Child, Henry William Robert, Briardale, 33, Crediton-road, West Hampstead, N.W.

Loch, Lieutenant Percy Gordon, I.A., c/o Messrs. Cox & Co., Hornby-road, Bombay, India.

Newlands, Lord, LL.D., 36, Grosvenor-square, W., and Mauldslie Castle, Carluke, N.B.

Prankerd, Miss Edith, 51, Campden Hill-court, Kensington, W.

The paper read was—

ILLUMINATED MANUSCRIPTS.

By Cyril Davenport, V.D., F.S.A.

Illuminated manuscripts form an important division of water-colour painting in a small or miniature size. The earliest existing manuscripts are Egyptian, and some of them are illuminated, or ornamented with pictures. Early Egyptian paintings on papyrus are done in water-colours mixed with white, known as body-colour, tempera, or gouache. The designs are outlined in black or red and filled in with flat washes of colours, all of which have proved permanent. The colours used are iron-red, copper-blue, and green (and later, lapis lazuli blue), yellow earth, ochre, lampblack, and

* Vol. LI. p. 67.

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chalk or white clay. Some of the books of the dead—particularly the Papyrus of Ani, written about 1500 B.C.—show these interesting paintings to perfection.

Until about the second century B.C. papyrus remained the chief substance upon which writings were made, but at that time a scarcity of supply occurred, and Eumenes II., King of Pergamum, introduced vellum, prepared from calf-skin, as a substitute. Vellum quickly superseded the brittle fibre of the Nile reed, and became, as it still remains, the ideal material for writing and illumination.

From the fourth century onwards, until the sixteenth, we find an unbroken series of European illuminated manuscripts on vellum; and the illustrations found in these follow, in the main, after about the thirteenth century, the general characteristics of the art of their particular period and country.

The schools of illuminated manuscripts may be very roughly divided into two main divisions —the Byzantine and the Gothic—each of which may again be subdivided almost indefinitely.

In A.D. 330 the Emperor Constantine went to Byzantium, and the great early epoch of Christian art began shortly afterwards. It was, primarily, a religious movement, and in some sort a reaction against the classicalism of Rome. Oriental feeling is evident. Asia Minor, Syria, and Africa, all influenced Byzantine art. No doubt numbers of pre-Byzantine manuscripts existed, but they have almost all disappeared. There were great losses of libraries at Constantinople, Alexandria and Rome, and numbers were also destroyed by the Iconoclasts in the eighth century.

Byzantine manuscripts are written in Greek; the vellum is sometimes stained purple, and the early writing is in large letters of gold and silver. The style reached its highest point of excellence about the tenth and eleventh centuries, and its influences are still apparent in the ritual of the Greek Church and in Russian religious art generally. The effects are richly decorative and gorgeous in colour, the figures stately, with carefully arranged drapery and accessories. As authority for ceremonial, manners, costume and furniture, the value of illuminated manuscripts cannot be overstated.

So-called Byzantine influence was strong in European illuminated manuscripts until the twelfth or thirteenth centuries, when the work of each country began to differentiate according to the national influences brought to bear upon it. After this it becomes possible, with increasing certitude, to attribute a given piece of illumination to a definite country of origin. At the same time it must not be forgotten that, as the knowledge of minute peculiarities of style increases, many manuscripts that can at present only be classed as Byzantine, will probably be more definitely placed. Early manuscripts, so far as styles go, are indeed largely composite productions, and many influences have been brought to bear upon them.

Early Byzantine manuscripts commonly contain full-page miniatures, and the script is large, the letters often being uncials (*uncia*—an inch), or what we might call small capitals. Later manuscripts of the eleventh and twelfth centuries or thereabouts, are usually in small letters (minuscules), and show small miniatures in borders, headpieces and groups.

About the end of the twelfth century a remarkable change took place in the general style of production and ornamentation of manuscripts. Generally the books tended to become smaller (although until the fifteenth century large books were often made in Italy, France and Flanders), and the writing as well as the illuminations became more delicate. Much attention was now paid to the decoration and exemplification of initial letters, which began to be ornamentally extended upwards and downwards along the blank margins of the pages, and the full-page miniatures of the Byzantine period tended to disappear. The Gothic style may be said to have prevailed from the twelfth or thirteenth century until the fifteenth century, when, for the remainder of the time of production of illuminated manuscripts, it merged into Renaissance styles, particularly in Italy and Flanders. Gothic influence was most marked in the work done in England, France, and Flanders, where it caused a remarkable development, but in Italy it had only a slight influence. The periods of highest distinctive development of the art in Europe took place in the thirteenth and fourteenth centuries in England, in the thirteenth, fourteenth and fifteenth centuries in France, and during the fifteenth and sixteenth centuries in Italy and Flanders.

The classical Renaissance, which began in Italy about the middle of the fifteenth century, had some effect on Italian illuminations, and also on Flemish, but it came too near the period of the end of the art altogether to have a universal influence.

The art of illumination in Spain, Bohemia,

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Hungary, and Poland never reached any distinctive eminence. The work done can only be considered as a variety of one or other of the well-known styles.

Ireland.

Now it is necessary to go back into the earlier period of the art of illumination in order to consider a most interesting and beautiful school of ornamentation that possesses rare peculiarities of its own. The Byzantine School was pictorial—the Celtic, which we are now considering, is ornamental. The ornamental ideas which are so exquisitely shown in Celtic manuscripts have undoubtedly had very great influence over the imaginations of designers of European manuscripts. Traces of this influence can be seen for a very long time in purely ornamental work. As well as "Celtic," this school may be called "Irish," "Anglo-Irish," or "Hiberno-Saxon." In any case the inspiration is certainly from Ireland, if not the actual execution. Irish scribes, celebrated in early times, migrated freely to the Continent, and their work was very highly esteemed. The chief examples of illuminated Celtic work now existing are:—

The Book of Durrow. At Dublin. Seventh century.

Dimma's Book. At Dublin. Seventh century.

The Lindisfarne Gospels. In the British Museum. Eighth century.

St. Chad's Gospels. At Lichfield. Eighth century.

The Book of Armagh. At Dublin. A.D. 807.

MacRegol's Gospels. At the Bodleian, Oxford. Ninth century.

The Book of Kells. At Dublin. Probably eighth or ninth century.

MacDurnan's Gospel Book. At Lambeth. Ninth or tenth century.

So that, although the actual dates of these Irish manuscripts are very uncertain, it is clear that, for about four hundred years, we know that Irish scribes and illuminators produced magnificent manuscripts, a few of which still exist. The ornamentation is the most remarkable point in these manuscripts. We find a bewildering mass of interlacing forms, human, lacertine, serpentine, quadrupeds and birds, then there are curves and spirals, plaited and knotted work, and tessellated designs in great profusion. These ornamental motives resemble contemporary work in bone, stone, metal and basketwork, and some may, I think, have been derived from woven work. Many of the three lobed ornaments, "triquetra," nearly resemble modern Japanese designs, and similar work to many of the curves and interlacings can be traced in Maori wood-carvings. The colours used are generally thick and opaque, probably mixed with glaire of egg as a medium. The most commonly used are light red or orange, green, blue, purple, pink, yellow. The designs, however involved, are measured out in a masterly way, and exquisitely drawn. The outlines are in black or brown. A few words here and there are written in powder gold, but I do not think leaf-gold has been originally used in any of these manuscripts. There are some parts of the Lindisfarne Gospels picked out with leaf-gold, but I believe these to have been added at some late period. The ornamental designs are often outlined with small red or orange dots.

England.

English work from the eighth to the twelfth centuries shows some Byzantine and Celtic feeling, combined with other influences. Anglo-Saxon work is of great interest, especially for the curious outlining, and the peculiar attitudes of the figures. In the tenth century there was a large output of beautiful work, mainly coming from Winchester, Westminster, St. Albans and Exeter. The framework or borderings of many of the full-page miniatures are often of great beauty. In the twelfth century the Gothic style began to assert itself, and the work generally tends to become smaller, and more delicate. The thirteenth and fourteenth centuries saw the same style continued, the Gothic influence affected English and French illuminators in the same way, so that the difference between them is often very difficult to detect. Initial letters become more and more ornamental, and the full-page miniatures tend to disappear. In the fourteenth century the highest point of excellence in English illumination may be said to have been reached. There are fine "bar" and "frame" borders, reminiscent of the beautiful Winchester work of an earlier time, and there are many instances of small grotesques and imaginative and fancy designs in borders and initial letters. "Queen Mary's Psalter" belongs to this period. On some of the fragments of a Bible made for Richard II. appears a remarkably beautiful tracery on gold-leaf backgrounds, a small decorative pattern traced out by means of pointillé work, a manner of working that for delicate charm is unequalled. The "Sherborne Missal," belonging to the Duke of Northumberland, is also a magnificent specimen of English work. The fifteenth century saw the decline and practically the end of the art of

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the English illuminators, and later work of this kind done here was chiefly the work of foreign artists, mainly Netherlandish.

Although printed books have finally superseded illuminated manuscripts, except as luxuries, the capacity of English artists to produce the latter in a style that need fear no comparison at all is shown in the case of an exquisite little manuscript recently presented to the British Museum by Lady Burne-Jones. It is a copy of Fitzgerald's "Rubaiyat" of Omar Khayyam, translated, written and illuminated by William Morris in 1872, with figures painted by C. Fairfax Murray, from designs by William Morris and Sir E. Burne-Jones.

France.

In France, in the eighth and ninth centuries, occurred what is known as the "Carolingian Renaissance," due to a revived interest in art matters initiated and fostered by Charlemagne himself. In the main, this art was influenced by that of Rome and Ravenna, as well as that of Byzantium, and it also shows the influence of Moorish and Celtic art. Purple vellum and gold letters appear, but the work is coarsely executed. The great centres were Tours, Rheims, Metz and Aix-la-Chapelle.

In the thirteenth century in France the art of illumination generally began to throw off its Byzantine fetters, and with the advent of the Gothic wave of art, French artists readily fell in with the feeling of the new style, with which they quickly became identified, and in which they remained paramount until about the middle of the fifteenth century. Illuminated manuscripts became part of a recognised craft, and gradually ceased to be the monopoly of religious orders. Secular subjects were freely treated, and borders and accessories often show architectural motives. Minute lettering was much liked, and most delicately and beautifully executed. Besides Bibles and Psalters, numbers of herbals and bestiaries were made. Romances were produced in considerable numbers, and so were works on medicine and surgery: many of these show very interesting paintings of actual operations.

In the fourteenth century the great and varied output of French illuminators continued in an even increased degree, and most of the illuminated manuscripts made in other countries followed closely on French lines, which set an example to be followed all over Europe. Among the most distinctive smaller peculiarities found about this time in French illuminations may be noted fine diaper or tessellated backgrounds, the presence of a graceful running design of small gold ivy leaves, now and then in colour, and many illustrations showing figures in monotone or "grisaille."

During the fifteenth century the output of fine illuminations in France continued with vigour, beautiful work was done for the great collectors—the Duc de Berry, and John, Duke of Bedford. The illuminators whose names are best known, are Pol de Limbourg and Jehan Foucquet. Towards the end of the century came the decadence, and shortly after the advent of printed books the production of written manuscripts died out.

Italy.

In Italian illuminated manuscripts a similar course to the French may be observed, but the period of greatest excellence began a little later. We have seen that in France this period began in the fourteenth century, but in Italy it may be said to have begun about the fifteenth, and to have lasted into the sixteenth.

Before 1300 A.D., many Greek manuscripts were written in Italy. In early Italian illuminations curious rectangular nimbi were used to denote living personages. Celtic art shows its influence in many cases. The "Exultet" rolls made at Monte Cassino have the illustrations painted the reverse way to the script, so that a reader reading the roll and allowing it to drop over the desk before him, would show the pictures right way up to the audience.

The Gothic influences which so strongly influenced French and English work in the thirteenth and fourteenth centuries, had not so marked an effect upon Italian illuminations, which were, however, at that time at a period of comparative unimportance. Flesh colour shows a grey tinge with greenish shadows. Gilded studs or discs with filagree scrolls in pen-work often appear. At the period of the Renaissance, about the middle of the fifteenth century, the flowering period of Italian illumination began; now we find fine and brilliant work with distinctive and delicate designs and beautiful bright clear colour. The gilded discs still remain favourite, but a worthier peculiarity is found in the rich and decorative borders and patches ornamented with a design founded on a white interlacing spray of vine stalk with tendrils, often interspersed with animals, putti, masks, and other ornamentation at intervals. Beautiful books were made at Florence and Milan. The Sforza Book of Hours was made at Milan for Bona of Savoy about 1490, and Attavante degli Attavanti worked at Florence. In the sixteenth century

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worked Giulio Clovio, a most clever miniaturist and very fond of shell gold. He was the last great Italian illuminator, and even his work shows the signs of decadence.

GERMANY.

On the decay of the Carolingian Renaissance in the ninth century—a renaissance which, to a considerable extent, affected German work, arose a more particularly German revival, known as the Ottonian Renaissance. In the tenth century Otto II. married the Byzantine Princess Theophano, and from Hildesheim, Richenau, Treves, and Ratisbon came many fine manuscripts in that and in the succeeding centuries. The work was coarse, with strong flesh tints. Large patterns are found with striped and interlaced backgrounds and hard technique. In the twelfth century there was a large output of big Bibles. German illuminations have always been more or less heavy and large.

FLANDERS.

Illumination in Flemish manuscripts began slowly to develop about the thirteenth century, and to differentiate in a similar way to that noticed in England and France. In the fourteenth century the production of illuminated manuscripts remained small; many Flemish miniaturists worked in France, and their work is difficult to distinguish from French work.

In the fifteenth century a greater activity shows, and the art attained a high level. Much distinctive work was done, delicate landscapes are plentiful, and many paintings in grisaille, often on monotone coloured grounds, are found. Excellent and typical work continued well into the sixteenth century, when most of the European countries had ceased their output. In the later period in Flemish work we find numerous examples of broad borders enclosing the script. These frame-like borders are rectangular and painted with flat monotone grounds, grey, pink, purple, and sometimes dull gold. On this groundwork are scattered flowers, fruits, birds, and insects delicately painted in natural colours, but with strong shadows, giving an appearance of high relief.

The latest glory of Flemish illuminated manuscripts is the "Grimani Breviary," now at Venice, executed about 1510. Some fine Flemish miniatures were added to the Sforza Book of Hours, painted in a like manner to the Italian work preceding them.

Like the other European schools of illuminated manuscripts, the Flemish, lasting longest, finally succumbed before the victorious march of the printing press.

Now that all these beautiful productions may be considered as examples of a no longer living art, we are able to consider them in a proper perspective, and as a whole. I feel sure that no one who has ever been privileged to examine the finest examples left of this exquisite art, whether in private hands or in public museums, can possibly fail to award the highest possible meed of praise and admiration to the mediæval monks, artists, illuminators, gilders, and scribes who produced them, many of whom were, undoubtedly, the best artists of their time.

DISCUSSION.

THE CHAIRMAN (Sir Walter Armstrong), in opening the discussion, said the difficulty in discussing the paper was to discover any point on which to differ from the author, and he therefore proposed, in the few remarks he desired to make, to amplify rather than criticise the excellent paper that had been read. Some of the earliest illustrations shown by the author dealt with Irish manuscripts. It always seemed to him that, in discussing Celtic ornament, especially the characteristic interlaced designs, sufficient stress had not been laid upon the fact that they were almost identical with the designs that were used by the metalworkers. In following a scroll or an elaborate interlacement through all its intricate ends, it was difficult to make it wrong in metalwork, and he thought the Irish must have learned their extreme accuracy in carrying out designs in illuminated manuscripts from the influence of their metalworkers. The Book of Kells was a perfectly marvellous piece of work from that point of view. He differed, however, from the author in thinking that the Book of Kells was the most beautiful Irish illuminated manuscript. It was far and away the most elaborate, but he thought, as a work of beauty and of artistic imagination, it was not to be compared with the Lindisfarne Gospels. So far as elaboration went it was a miracle, because it was possible to go through the most elaborate scrolls and interlacements and never lose hold of any of the threads. For instance, if the tail of one of the curious animals or snakes was found it was easily possible to find the head; in fact, the whole thing was a miracle of the virtues of extreme patience and contentment on the part of the workman, virtues that were getting rare in the present day. He also wished to mention the great vigour that was shown in the English illuminations down to the time when they lost their supremacy. As the author had stated, English illuminations were supreme down to some time in the fourteenth century; the end of their supremacy was generally put at about the time of the Black Death, in the middle of the fourteenth century. Up to that time they seemed to be characterised by more artistic vigour than any other illuminations, not only up to then but

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since. There were a great many specimens in the British Museum which showed an extraordinary vivacity in the utilisation of dramatic motives. They were generally not the kind of illuminations which were the most attractive to reproduce, because they were mostly linear and not much in the way of colour, but they showed a vivacity and a power of dramatic design which he did not think reappeared at all in the art of illumination after that time.

MR. CECIL HALLETT said that, so far as he had observed, the effect of illuminated manuscripts upon the ordinary visitor to the British Museum was most disappointing. To his mind the manuscript room was one of the most interesting in the whole Museum; nevertheless, as he had experienced only that afternoon, it was the one part of the Museum in which he found it most difficult to interest an ordinary audience of visitors. He recently ventured to tell some visitors so as pleasantly as he could, suggesting at the same time that it was a kind of imputation upon our national character. All visitors seemed to be interested in the mummies but not in books, and he always dreaded the hour when it was his duty to show people the illustrated manuscripts and books. Of course, the trouble might be due to the fault of the guides. He desired to ask the author, in conclusion, how the Byzantine influence reached this country. Was it through the Norman Conquest?

MR. ROBERT STEELE was sure the audience would desire to express its extreme admiration for the enormous technical skill shown by the author in the production of the beautiful slides that had been shown. When it was remembered that the slides thrown on the screen, which appeared as pictures several feet high, were drawn and coloured by the author in the space of about an inch in length, those who had done any drawing would recognise the great skill that had been displayed. Turning to the subject of the lecture, the development of Celtic art had always seemed to him a most interesting chapter in the history of design. There was a main line of design in ornament which ran straight down from Greek times, through Rome, Italy and France, although not perhaps so much in manuscripts as in sculpture, and continuously down to the present day. This was an art of which almost nothing was known, but which one was led to suspect in Asia Minor, which ultimately produced Byzantine art, and through Byzantine art and its modification of Italian art had led to Romanesque and Gothic in its various ways. But in none of those arts was any affiliation found with the Celtic manuscrips. Skilled motives were discoverable in savage art right through the world. But in Mr. Herbert's book on manuscripts, a very magnificent book produced quite lately in the series under the author's charge, a hint was given which he thought solved the problem. In all other countries illuminated manuscripts passed from hand to hand; for instance, they were brought by the early missionaries from Rome to England; but as far as was known the missionaries who landed in Ireland were very poor men, with very small manuscripts which had no ornament on them at all. When the ornament had to be produced it was done by a generation which had grown up quite independently, which knew nothing of the beautiful books of the Roman Church, and which was cut off from the books of the Roman Church by a difference of ritual. When they started the ornament they had to adopt the ornament of their own metalwork; and the illumination in the book was a copy of pre-existing metal ornament which was perhaps connected with the Norse ornament. Mr. Herbert had worked the history out in an excellent way, and he thought that point ought to be borne in mind. It was difficult to raise any discussion on the paper. The author had given so complete an outline, and at the same time had so carefully avoided any of the points that were not yet settled, that it was only possible to compliment him on his dexterity as well as his knowledge. He regretted very much that the author had not shown any slides of the "Exultet" Rolls. There was in the Museum a most beautiful roll, to which the author had referred, relating to a little service introduced into Monte Cassino in the thirteenth century on one of the early Sundays in Lent. It was then the custom to sing a number of Psalms, and on each Psalm being sung a candle was put out; and on turning over each of the rolls magnificent illuminations of the scene were found. He knew nothing about them until Mr. Herbert's book appeared, and when he subsequently inspected the rolls it seemed to him that the rise of Giotto and the whole of his school was explained. Giotto and his school in painting were practically without father and mother in the history of art, but in looking at the "Exultet" Rolls the real origin of the school was apparent. He would have been very glad indeed to have seen slides of those rolls among the pictures the author had shown.

THE CHAIRMAN, in proposing a hearty vote of thanks to the author, said it was impossible to do so without referring, as Mr. Steele had done, to the extraordinarily beautiful set of slides that Mr. Davenport had shown. The skill which had been displayed in their production was almost equal to that of the old illuminators themselves. The next thing Mr. Davenport ought to do was to illuminate a book, and to revive an art which deserved reviving.

The resolution of thanks having been carried unanimously,

MR. CYRIL DAVENPORT, in reply, thanked the audience for the vote of thanks they had accorded to him. He was very pleased to hear the chairman's remarks with regard to the Book of Kells and the Lindisfarne Gospels, because they rather echoed what he felt himself. A very great authority, Professor Westwood, had said, however, that the

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Book of Kells was a finer piece of work than the Lindisfarne Gospels, and that was why he did not like to say it was not. He wished to thank Mr. Robert Steele for his very able contribution to the discussion, and promised him that before he heard the lecture again he would be able to show him a very good slide of an "Exultet" Roll.

MR. ALAN S. COLE, C.B., writes as follows:—"I am sorry that a bad cold prevents me from attending the meeting this evening, when Mr. Davenport is to read his interesting and valuable paper on Illuminated Manuscripts, an advance copy of which I have had the advantage of reading. Had I been able to be present, I should have ventured to point out their value in throwing light upon sources of design for embroideries and tapestries, etc. I made some allusion to this in the Cantor Lectures which I delivered in 1905, since when I have been fortunate in having under my hands some of the finest illuminations known. One of the most elaborate pieces of embroidery in Europe is the so-called Dalmatic of Charlemagne, preserved at St. Peter's, Rome. It has been much discussed, and its work attributed to a period of from two to four hundred years later than Charlemagne. But the illuminated Sacramentary given about 826 to the Archbishop Diogo of Metz, and the Vivianus Bible presented to Charles the Bald about twenty years later, seem to prove that the magnificent design for the Dalmatic may quite well have been produced in Charlemagne's time, and that the tradition of the Ecclesiastics at Rome has greater claim on belief than the opposing opinions held by the erudite antiquaries. Again, it is equally interesting to note that the famous worsted embroidery on linen, commonly called the Bayeux Tapestry, displays incidents of the Norman Conquest represented in a style identical with outline drawings in Œlfric's Pentateuch of the eleventh century in the British Museum. Many thirteenth and fourteenth century illuminations seem to have been the sources of supply for groups of figures in embroideries like the well-known Syon Cope, and even stained-glass panels like those of the Pricke of Conscience window at York. Designs for tapestry wall-hangings have certainly been derived from illuminations. Hennequin or John of Bruges adapted from a manuscript belonging to Charles V. of France representations of various subjects in the Apocalypse, which were in due course woven in tapestry for the Duke of Anjou, and supplied by the Paris merchant, Nicolas Bataille, in instalments between the years 1376-90. The greater part of this set of tapestries is now in the cathedral at Angers. Some fifty years later Jehan Foucquet, to whom Mr. Davenport has given particular mention, painted the superb full-page illuminations of the 'Grandes Chroniques de France'—now in the Bibliothèque Nationale—which are highly suggestive of designs for tapestry. But, besides these, there are in the Louvre a set of monochrome drawings, about ten inches by seven, attributed to Jehan Foucquet, illustrating events in the Siege of Troy. At the Victoria and Albert Museum we have a hanging 21 feet by 13 feet which reproduces one of these drawings—the one relating to the coming of Queen Penthesilea and her Amazons to the assistance of King Priam. Enlargements on so large a scale, and for decorative stuffs in demand for religious and lay purposes, contributed to the great development in the fifteenth century of the practice of drawing and painting then arising, which, however, the art of illumination had nurtured on a smaller scale for over some thousands of years previously."

THE QUEBRACHO WOOD INDUSTRY OF PARAGUAY.

The word quebracho is a contraction of the colloquial Spanish and Portuguese term, "quiebra-hacha," originally applied to many trees in Latin America. It means a "breaker," and the character of the timber is implied in this meaning. Species of the quebracho tree are to be found growing in the Chaco country of Paraguay, Brazil, and northern Argentina, the red coloured being the one containing tannin, used in the manufacture of the extract so valuable in the tanning of hides. It is used also for furniture. Every portion of the tree is utilised for the extraction of tannin. In Paraguay and the Argentine Republic the wood is a valuable asset, the land bearing the trees selling from £600 upwards per square league. During one year Paraguay manufactures many thousand tons of extract, and the United States imported in 1910 over £850,000 worth of quebracho for tanning and other purposes. Much of this wood comes from the Chaco region of South America, which belongs to both Argentina and Paraguay, but the largest area is part of the latter country, and it grows wild in all parts. Gathering quebracho is now a recognised industry, and so extensive has it become that even railways are pushed into the wilderness to facilitate the ever-increasing supply to market, while steamers travel up the rivers emptying into the Parana so as to be on hand to receive the wood or the extract as it is brought from the forest, and whole settlements gather and leave permanent traces over this immense tract of Paraguay where quebracho grows. Quebracho may be cultivated, although the tree is of slow growth, but the necessity for that step may arise if the demand continues. In addition to its great value as furnishing tanning material, the tree is of great service in railway and fence construction in South America, for the wood is extremely hard and seems to be the only material immediately available for sleepers; its reputation has spread so widely that many sleepers are at present being exported to Europe. The industry of extracting tannin from quebracho had its origin in France, where a consignment of logs was sent from Paraguay in 1874. The first factory in South America for the manufacture of the extract was erected at Puerto

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Casado, Paraguay, in 1889, followed a few years later by others, to support which thousands of leagues of quebracho land in the Paraguay Chaco were bought.

AREA AND POPULATION OF THE GERMAN COLONIES.

The colonial extension of Germany is of comparatively recent growth. Previous to 1880 the colonies were unimportant, and it was not until after the death of Prince Bismarck that the colonial policy of the German Empire has been to extend her possessions beyond the seas.

According to the latest statistics, the colonies of Germany cover an area of 2,658,500 square kilometres (1,026,181 square miles), with a population of 13,943,970, or only 5·25 persons per square mile. The proportion of whites to the native population is also very small, being only one to 580.

The areas and population of the various colonies are as follows:—

AREAS.

	Sq. Kilometres	Sq. Miles.
East Africa	995,000	384,070
South-East Africa	835,100	322,348
Cameroons	495,600	191,302
New Guinea	240,000	92,640
Togo Land	87,200	33,659
Caroline Islands	2,476	956
Samoa	2,572	993
Kiao-Tcheou	552	213
Totals	2,658,300	1,026,181

POPULATION.

	Native.	European.
East Africa	10,028,000	3,756
South-East Africa	69,000	12,935
Cameroons	2,302,000	1,284
New Guinea	301,000	688
Togo Land	1,000,000	372
Caroline Islands	20,000	566
Samoa	35,000	473
Kiao-Tcheou	165,000	3,896
Totals	13,920,000	23,970

The total value of the trade with these colonies is estimated at 255 million marks (£12,750,000), of which 115 million marks (£5,750,000) represent the imports, and 140 million marks (seven millions sterling) the exports. Taking into consideration that in these amounts Kiao-Tcheou figures for 100 million of marks (five millions sterling), the value of the trade of the German colonies must be considered insignificant when compared with their extent. The value of the imports of Germany to her colonies, although showing an increase from 25 million marks in 1900 to 42 million marks in 1909, only represents about one half of the total import trade. The export trade, although it has increased considerably during the last ten years, does not appear to have benefited German ports to the extent that might have been anticipated, a large proportion being with other countries.

THE PRODUCTION OF OATS AND BARLEY IN FRANCE.

The production of oats and barley in France during 1911 shows an increase on that of 1910. The following official statistics, published by the Minister of Agriculture, show the areas cultivated and quantities produced of these cereals.

AREAS CULTIVATED.—OATS.

Year.	Hectares.	English Acres.
1911	4,040,100	9,979,047
1910	3,951,300	9,759,711
Increase	88,800	219,336

QUANTITIES PRODUCED.

Year.	Hectolitres.	Bushels.
1911	107,288,400	295,043,100
1910	102,469,000	281,789,750
Increase	4,819,400	13,253,350

The average yield is 26·55 hectolitres of oats per hectare (29·56 bushels per acre) in 1911, as compared with 25·93 hectolitres per hectare (28·88 bushels per acre) for the whole of France in 1910.

The quantity of barley was:—

AREAS CULTIVATED.

Year.	Hectares.	English Acres.
1911	774,425	1,912,829
1910	748,480	1,848,745
Increase	25,945	64,084

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QUANTITIES PRODUCED.

Year.	Hectolitres.	Bushels.
1911	17,201,240	47,303,410
1910	15,321,300	42,133,575
Increase . .	1,879,940	5,169,835

The average yield is 22·21 hectolitres per hectare (24·75 bushels per acre) in 1911, and 20·47 hectolitres per hectare (22·8 bushels per acre) in the previous year.

ARTS AND CRAFTS.

Lettering.—The most fastidious amongst us have been congratulating ourselves of late on the improvement which has undoubtedly taken place in recent years in lettering of various kinds—printed, carved, painted, and written. Not only are notices, titlepages, signs, etc., far better than they were even a few years ago, but posters and other kinds of advertisements are, as a rule, far less offensive than they used to be, and are sometimes quite pleasing to look upon. Again, as a result of the teaching of script in the art schools, it is now quite common to see addresses and simple pieces of writing well spaced, good in form and generally satisfactory. The writing usually taught in schools of art, however, has very little to do with the kind of current hand which is necessary in the everyday affairs of life, and it is by no means unusual to find that the ordinary handwriting of a student who writes really beautiful script, is poor and weak, if not appallingly bad. Perhaps the gulf between the two sorts of writing is responsible for a state of affairs in one of the departments of lettering which can only be described as deplorable.

Many of the senders and recipients of Christmas and New Year cards are too intent upon the wishes conveyed in them to pay very great attention to the form in which they are presented; but anyone really interested in lettering, printing or writing, could hardly fail to be depressed after turning over a dozen books full of this season's greeting cards. The carefully printed, embossed or engraved words which formed part of the decoration of the front page were sometimes (though by no means always) quite adequately rendered, but the more personal wishes within were, for the most part, extraordinarily badly done. When Roman capitals had been made use of, or some other ordinary printing type, the result was sometimes fairly satisfactory, though often enough the fount employed was by no means the best; but when it came to current hands and formal writing of various sorts the work was poor beyond all expectation or forgiveness. The hands used were usually cramped and stilted, and quite unharmonious, whilst the flourishes were for the most part altogether meaningless and added apparently at random. Finally, the taste which should have been apparent in the setting out of the page, was too often conspicuous by its absence. It is comparatively easy to understand the point of view of the person who dislikes and will have none of what he describes as "fancy writing," but if we are to have decorative, or indeed formal, writing at all, it should surely be based on good models. The old writing masters had many failings, especially the later ones, and some of these perpetrated work which no one in his senses would wish to drag from the well-merited oblivion in which it is buried; but amongst the others are men like Palatino, Yciar, De Beaugrand, and Davies of Hereford—to mention at random only a few—who have much to teach to those willing to learn. If the training of the people who are going to do this kind of work included a study of a few of the best hands of earlier writing masters, things would at least be less bad than they are at present. When we turn to the cards, whose ornamentation consists almost entirely of lettering, much the same state of affairs is observable. Those which depend on current or cursive writing are generally thoroughly unsatisfactory—lacking in spontaneity as well as in grace of line and daintiness of composition. For some years past, however, a certain number of cards, well and tastefully written in half uncials and Roman characters, have been issued, and these continue, as far as the lettering pure and simple is concerned, to be quite adequate; but the revival of illumination has had rather a bad effect upon them. It seemed to be essential this year that they should begin with an illuminated initial, and that as a rule some further ornament should be added. Now a really beautiful illuminated initial is in itself one of the most satisfying forms of decoration, but the combination of such an initial with the remaining text and its relation to the page as a whole is a matter which always requires very careful consideration—even more consideration when the page is small and the text short than in the case of a closely-written quarto or folio—and it is just this point which has been overlooked by the Christmas-card writers and illuminators. They have generally overweighted their text with unwieldy initials and overloaded it with superfluous ornamentation. Now the ordinary student has been carefully taught to do script nowadays, and he quite often does it very well, but when he tries to combine it with illumination and adapt it to a Christmas card he too often fails. Perhaps some people would say that is because he has been taught too much; but is it not at least as likely to be because he has not been taught enough? We talk a great deal just now about originality and allowing the student to find his own way, but we neglect to furnish him with the necessary outfit for his journey. After all, there is such a thing as taste, and unless a man learns something about that his artistic equipment is lacking in an absolutely essential feature. It is sometimes said, with a certain amount of truth, that taste cannot be

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taught; but it can be cultivated, and it should be the business of the schools to set about doing it.

Arts and Crafts and Home Industries in Italy.—The more one sees of Italy the better one realises that an arts and crafts movement, as we in England understand it, not only does not, but cannot, at present exist. The movement with us was necessitated by the decay of the artistic crafts, which, owing to various causes, mainly economic, were felt to be altogether in a bad way. It was, at the outset, essentially a movement of artists—mainly of designers and architects—who turned their attention to reviving various crafts which seemed in danger of being either extinguished or entirely swallowed up by manufacture; and though none of the original movers made fortunes by their efforts, some of them at any rate earned quite a comfortable livelihood. In Italy the case is quite different. With the exception of Milan, which is more or less like any other big city, the Italian towns have retained their own characteristics to a very marked degree, and along with them their own artistic industries. Some of these may be, from the point of view of art, in rather evil case, and others are being more or less ruined by foreign tourists of different nationalities, very ready to gush over characteristic work, and quite unwilling to pay for really good workmanship. But the industries, such as they are, remain, sometimes conducted on a fairly large scale, but quite frequently carried on by small men, who employ half a dozen hands or so, and are content with a very modest livelihood, and while this is the case there is little or no chance for artists who take to handicraft to earn what they would be likely to consider a living.

But whilst an arts and crafts movement is to seek, there is a very strong effort in favour of home arts and industries, although it is unlike our British movement, in so far as it is practically confined to women's work, and consists mainly in an attempt to revive or keep alive amongst the peasant women throughout Italy their own traditional needlework. Some of this work is, of course, famous throughout the world. Who has not heard, for instance, of Venetian point? And at various exhibitions in London we have had opportunities of seeing the beautiful drawn threadwork which comes from Æmilia, and (since the Messina disaster) some of the Sicilian industries. But work is being done in Tuscany and Umbria which, though it is less well known, is extremely interesting, and distinctly recalls some of the most unusual work in the Bargello—that in coloured silks on a white or écru linen ground. The ground stuff is left to form the pattern, which stands out in white against a worked background of red, green, brown, or blue as the case may be. It is in this combination of white and colour that the north and central Italian embroidery and drawn threadwork seems to excel. White work is for some purposes unrivalled, but embroidery in colour on white linen offers a far greater scope to the worker. The Sicilian needlework, however, is perhaps the most interesting of all, and large quantities of it are being done. One comes across a piece of coloured work now and again which might well have come from the Greek islands, but the embroidery as a whole is entirely white, and includes, besides beautiful drawn threadwork of the type of Greek lace, that much more unusual work in which, while no threads are drawn out, the background is formed by drawing the threads tightly together into a simple lattice pattern, whilst the design stands out from it in the plain material. Some of the patterns executed by this method, though they are supposed to be copied from Saracenic originals, are too incoherent to be very satisfactory, but the workmanship is extremely interesting. It is rather odd that in places so far apart as Umbria and Sicily, and in such very different kinds of work, the same unusual practice of working the ground and leaving the pattern plain should obtain, though the designs in both cases rather suggest that they may, at some period or other, have been derived, or at any rate influenced, from an Oriental source.

EMPIRE NOTES.

The Royal Visit to India.—In His Majesty's message to the Prime Minister, on the eve of his departure from India, referring to the success of his and his gracious Consort's visit to that great Dependency, he says: "This satisfaction will be still greater, if time proves that our visit has conduced to the lasting good of India and of the Empire at large." In this hope all Imperialists will share, as the welfare and prosperity of India are bound up with the welfare and prosperity of all the oversea Dominions and Dependencies of the British Crown. The importance of the step taken by His Majesty in holding a Durbar in India, to say nothing of the changes which, on the advice of his Ministers, he announced, cannot but have a great and, it is believed, a permanently beneficial influence upon the peoples of that country, bringing them into closer union with each other, under British rule, and promoting the spirit of loyalty to the British throne.

The Congress of Imperial Universities.—Arrangements for holding the proposed Empire Universities Congress, which have been in progress for the last twelve months, are rapidly approaching completion. The meetings are to be held in London from July 2nd to the 6th, and it is hoped that the fifty-two Universities scattered throughout the Empire will all send delegates. Although only four days are allotted for the meetings, the oversea delegates, for a fortnight previous to the Congress, will be the guests of the Home Universities, and will have the opportunity of visiting these great seats of learning, and of studying, on the spot, the methods of teaching and administration in operation therein. This of itself will be most

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useful, both as a preparation for the Congress and as a means of bringing together the heads of the Home and visiting Universities. There are two committees charged with the duty of arranging for the Congress, and of receiving the delegates. Among the members of these committees are the Secretary of State for the Colonies, and the High Commissioners and Agents-General of the various Dominions. The Prime Minister, the Leader of the Opposition, and the Archbishop of Canterbury, besides a number of University leaders, are also members. Dr. Alexander Hill has been appointed general secretary. The Congress will discuss the important subject of improving the relations of the various Universities to one another; it will review the whole question of higher education within the Empire, and efforts will be made to give a practical issue to the discussion.

The Imperial Emigrant and his Political Religion.—Under this somewhat singular though attractive title, there is an article in this month's *Nineteenth Century*, from the pen of Mr. Arthur Hawkes, the Canadian Special Commissioner, sent to England to study the immigration policy of his government from this side of the water. "My mission," Mr. Hawkes says, "is to ascertain what methods are being followed by the Dominion and Provincial Governments to obtain immigrants, and to propose measures for more effective co-operation between them, with a view to increasing permanently the flow of immigration to Canada." In doing this, he proposes, by his article and any addresses he may deliver, to present to the British public "the emigrant, as the real custodian of the Empire's future, the living epistle of the only political religion that can preserve British unity throughout the world." From this point of view, he regards the emigrant as so important a factor in the growth and development of the Empire that he would fain make the average home-staying Briton become, for the moment, "even as an emigrant, that he may know the things that make for the glory of the country to which the emigrant goes, and the influence of that country on the one he is leaving." How far the writer may succeed in his purpose it is difficult to say, but that it is desirable for those who wish to promote the progress and unity of the Empire, but who themselves have no intention to emigrate, to view the question from the emigrant's standpoint, both on his outgoing and on his return to revisit the homeland, there can be no question. In any case, emigration to our oversea Dominions is a subject that needs to be carefully studied, especially in view of our congested districts, if we are to people the empty spaces of Canada, Australia, and South Africa with the British born, and, at the same time, to relieve the pressure of over-population at home. It is to the populous centres of the United Kingdom rather than to our country districts—which are being sadly depleted by migration to the towns as well as by emigration to our oversea Dominions and to foreign countries—that the attention of those who, like Mr. Hawkes, are desirous of inducing our people to emigrate, should be turned.

Canada and the New Year.—An interesting consensus of opinions as to Canada's new year's prospects, has been issued in a leading London Canadian paper, in which Canadian representatives of trade and commerce, one or two Premiers, and Ministers of Agriculture and Labour have taken part. According to these writers, the outlook of 1912 is full of promise. The President of the Canadian Bank of Commerce says: "The new year could hardly promise better for Canada. Immigration, railroad building, improvements to towns and cities, enlargement of factories, Clearing-House returns, the revenues of the Dominion Government, foreign and domestic trade, are all on a larger scale than ever before." The president of the Grand Trunk Railway system says, "the railways are showing larger increases in their gross receipts than is the case with the railways to the south of us, while in every branch of industry there is marked activity and increased business." A concrete illustration of this promised development is afforded in many of the new townships that are springing up along the railway lines, as, for example, in Red Deer, a town in Alberta, through and in connection with which three trans-continental and three branch lines are being constructed, making in all eleven lines now converging upon that town. As in its immediate neighbourhood there are the largest and most important coal deposits known in Canada, which will be tapped by one of the lines now in construction, Red Deer is likely to become an important industrial as well as agricultural centre. The same may be said of other towns in all the provinces, not excepting the Eastern Provinces, in which a progressive policy of railway development and land settlement has been adopted.

Victoria's Irrigation Lands.—Reference has been made in these columns to the various irrigation schemes of Australia, and, in passing, Victoria has been noticed. One prominent factor, however, in regard to the advantage to the settler afforded by these irrigation farms has been somewhat overlooked, which is that irrigated land is ready for occupation, so that the settler can commence farming operations immediately on his arrival on the land he has selected, or which has been selected for him. In the case of most non-irrigated Government land in Australia, the newcomer is called upon to perform years of arduous toil before his holding can be profitably worked, and thus valuable seasons are lost. Apart from this, farming is, of course, safer in irrigated than in non-irrigated districts, in view of occasional dry seasons. The Victorian Government is now renewing its efforts to secure applicants for this class of settlement, and a new departure in emigration to Australia will shortly be made in the form of conducted parties for intending settlers with capital. Arrangements for this purpose have been made with one

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of the leading shipping companies to grant a reduction in its saloon fares, by a boat leaving in the course of the next three or four months, in order to afford land seekers the opportunity of making a comfortable voyage to Australia. A pamphlet has recently been issued by the Victorian Land Commissioner in London, which points out what can be done by men with small capital, and by young men who intend taking up farming life, who will receive instruction in general farming, not only without fees, but with the promise of a small wage to be paid by the farmer, which will range, according to ability, from 5*s.* to £1 per week with maintenance.

Orange-growing in Western Australia.—One of the best districts in Western Australia for orange growing is known as Harvey. This district is situated in the south-west division of the State, at the foot of the Darling Range. From a picturesque point of view it is one of the finest in Australia, especially when the orange trees are in blossom. Oranges of all kinds have been successfully grown there for many years, and for size and flavour the Washington navel orange of Harvey is unequalled by any in the world. At Harvey the trees are cultivated in a highly scientific manner, and no trees are allowed to grow untended. Western Australia as a market for deciduous fruit has yet to be exhausted, and it will probably be some years before large shipments of oranges will be sent to London. Europe will be able, when the time comes, to take as many oranges as Western Australia can send, as the export season is at the time when such fruit would be in keen demand. For some time past the Government of Western Australia has had under consideration a large scheme of irrigation for the south-west division. Whilst the rainfall of that State is one of the most certain in the whole of the Australian Continent, it is felt that better results should be obtained from the land than hitherto. It is suggested that a commencement should be made in the Harvey district, as it lends itself admirably to irrigation, since it is possible to lock large volumes of water in the local hills by diverting the sources of the Harvey River in the winter into land-locked dams. There is one particular hollow in which, were a wall built on one side, thousands of millions of gallons of water could be stored. From its position water could be articulated for many miles over the eastern district of the south-west division, in which are some of the finest wheat lands of Australia. On the west and south-west side of the ranges are also some splendid fruit and dairy lands, the value of which would be considerably enhanced by the introduction of irrigation. On this subject a deputation of Harvey growers recently waited upon the Minister for Agriculture to urge immediate action. At Brunswick, about twenty miles from Harvey, a small irrigation scheme has been in successful operation for some years; the experience gained from this will be of great value to the Government in undertaking a larger scheme.

New Zealand's Revenue and Prospects.—According to a recent cablegram, the revenue of New Zealand, for the nine months ending December 31st last, shows an excess of £598,000 over the total for the corresponding period of 1910. This is an interesting and, indeed, a striking fact, read in the light of certain statements made in a recent article on some aspects of New Zealand life and legislation. Evidently, notwithstanding some defects inherent in all human affairs, the general progress and the continued prosperity of that Dominion are not greatly affected by the legislation, much of which is of an experimental character, in which the Parliament of that country has indulged during the last few years. Referring to the above statements, the High Commisioner, Sir William Hall-Jones says "There is no country in the world which exports as much per head as New Zealand." He further affirms that a great deal that has been done has "wrought substantial change for the better in the condition of the working classes," and he cites the factory laws as an example. A comparison of the financial condition of New Zealand to-day, with what it was a few years ago, cannot but be gratifying to New Zealanders. In 1904, for example, the bank deposits, other than those in savings banks, amounted to 19 millions sterling, while in 1909, the latest return available, they stood at just under 22 millions, and, what is a still more satisfactory indication of the general prosperity of the people, the savings banks depositors in 1909 numbered 408,770, and the total deposits amounted to over 14 millions sterling, or an average of £34 8*s.* 2*d.* per depositor, or £14 6*s.* 3*d.* per head of population. In all directions—industrial, agricultural, educational, and social—as far as these can be judged by reports and returns, there appears to have been a continuous and remarkable development in the prosperity of the country.

CORRESPONDENCE.

SACRED FISHES.

Some correspondents having been interested by the casual statements made by me of the veneration in which certain fishes were held by the now dead nations [Egypt, Babylonia, Israel, Greece, and Rome] of the Old World, and still are held by India, the only living integral survival of historical antiquity, and its fullest and truest interpreter [even before scattered and peeled Israel], reported in connection with Dr. Travis Jenkins's lecture on "The Fisheries of Bengal" in our *Journal* of December 22nd, it has seemed to me desirable to supplement what I then incidentally said, by this systematic and comprehensive Note on the subject; in the writing of which I have chiefly

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relied on such readily accessible authorities as the Bible, Homer, Herodotus, and Aristotle, and Pliny and Athenæus,—the information accumulated by the two last being overwhelming; at the same time overlooking nothing of pertinence to the question recorded by Plutarch ["Isis and Osiris"], Lucian ["The Syrian Goddess"], and Appuleius ["Magic"].

The earliest patent historical indications of the sanctity of specified fishes is afforded by their being held *tabu*, or "forbidden" for food, because they were *totems*, or reputed [Darwinian] ancestors, and hence heraldic signs, of certain tribes and peoples; and, where this explanation of their sanctity was lost, by their being held "an abomination," as by Israel to this day [Levit. xi. 9–12, and Deut. xiv. 9–10]; and assuredly not—not in the instances of fishes—because of their being regarded as unwholesome food: the other explanation in this connection of the sanctity of fishes being traceable, in casual cases, to statecraft, or priestcraft, or the cunning of individual epicures and fishmongers. Further Biblical references to the worship of fishes are to be found in Exodus xx. 4, and Deut. iv. 18, where Israel is adjured not to make any graven image in gold or silver, in the similitude of any figure, the likeness of male or female, of any fowl that flieth in the heaven above, or beast that is on the earth beneath, or of any fish that is in the waters under the earth, "to bow down to them and serve them" [after the manner of the surrounding pagans]; and again, possibly, in the mention, Song of Songs vii. 4, of "the fish ponds in Hesbon"; and (if the verse is rightly translated) in the judgment prophesied against Egypt, Isaiah xix. 10,—"And they shall be broken in the purposes thereof all that make sluices and ponds for fish."

Herodotus tells us [II. 77] that many kinds of fish were eaten by the Egyptians; and [II. 72] that two kinds, the Lepidotus and the Eel ["Phagrus"] were sacred throughout the Nile; while from Plutarch we learn that the "Latus" was held especially sacred at Latopolis, the "Oxyrhynchus" or "Pointed-Nose" at Oxyrhynchus, and the Eel at Phagroripolis, and Syene; it having been constituted an object of special worship at the former city in order to induce its inhabitants to keep the irrigation canals from the Nile in better order. The fish was also regarded in Egypt as a symbol of Isis, the wife of Osiris; the goddess, with their son Horus in her arms, being sometimes represented with a fish surmounting her head; and Horus himself as standing on a crocodile, and holding a fish above the aureole encircling his young head; both representations having, probably, as their immediate purpose, an astronomical significance.

Passing from the Nile to the Tigris and Euphrates, we find the myth of the Fish-man deity, Oannes [so named by Berosus, the Euahanes of Hyginus, Aos of Damascius, Oēs of Helladius, Hea (Fish-woman) of the Chaldæans, and Ea of the Accadians], coming up out of the Indian Ocean, and introducing the characteristic civilisation of Chaldea [afterward Babylonia] and Assyria, throughout Mesopotamia. This Protean (now masculine and again feminine) divinity has been identified with the similar Fish-man god Dagon [1 Sam. v. 2–7] of the Philistines; and with Derceto, or Atargatis, the Aphrodite Ourania of Herodotus, the Fish-woman goddess of the Syrians. But while, in our present imperfect knowledge, we must apply to this identification the caveat, "quod scis, nescis," the parallelism between all these Fish-human forms, as objects of ichthyolatry, from beyond "the river of Egypt," up to the confines of Persia, suffices for the purposes of this Note. Ninua, the daughter of Hea has also been identified with the city of Nineveh; its name [cf. Nun, "the Fish," a name of Hea], meaning, according to some, the City of "Fish-dwellers"; and the myth of Jonah, that reads so incongruously among the canonical scriptures of Israel, has immediate reference to Nineveh as a centre of Euphratean fish-worship; and although Jonah means "Dove," the dove and the fish are interchangeable as hierophallic symbols, and are absolutely consorted in the myth of the descent of Semiramis [Sammuramat] from Derceto or Atargatis. It is in the light of these fables that the full meaning of the Saviour's reply to the Pharisees and Sadducees becomes so clear:—"A wicked and adulterous generation seeketh a sign, but there shall be no sign given them but the sign of the prophet Jonas [Matt. xvi. 4]"; and again:—"The men of Nineveh shall rise up in judgment with this generation; for they repented at the preaching of Jonas, and behold a greater than Jonas is here" [Luke xi. 30]. The modern name of Nineveh, Mosul, if altogether of Arabic origin, can only mean, Place of "Confluence"; and any sort of conjunction, coupling or pairing [even as of the two lips, two nostrils, etc.] is a sacred thing ["juncta juvant"] in Hindu, and all pagan mythology. But I have before now drawn attention to the fact that Masulipatam, on the Coromandel coast of India, immemorially in coasting commercial communication with the head of the Persian Gulf, and so closely, as alone sufficient to explain the influence of the art of Babylon and Nineveh on its famous chintzes, as on the hangings of the temples of Southern India alike on the Coromandel and Malabar coasts, and on the sumptuary pile carpets, denominated, by European importers, "Malabar carpets,"—that the name of this town, correctly spelled, Machli-patam, also means "Fish-town." Again, Matsya, the Sanskrit word for "Fish," and the denomination of the "Fish-Incarnation," the very first *avatar* or theophany of the Lord Creator Vishnu, is also one of the most ancient and sacred names of India, as Fruitful of "Fish"; the direct reference undoubtedly being to the wealth of the Bay of Bengal in fish, particularly about the mouths of the great rivers that debouch into it; although some consider this name to refer also to the countries, Kathiavar, Gujerat, etc., about the Gulf of Cambay. The root of the word *matsya* is *mad*, "joyousness," "liveliness," "gaiety," "intoxication" [compare *madad*, an "opiate pill," and Madana, the "Goddess of Love," "Delight," etc.]. When I returned to Bombay in 1854–5, a story was

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current there of a Lord Stanley ["the Rupert of Debate"?] having been there some time before and putting up in Colaba simply to eat Pomfret. If true, the story should not be let pass into oblivion. But the most fascinating fish in all India is the "Bombay Duck," in that up to this date it has defied all attempts convincingly to demonstrate the etymology of its endearing name. It is probably of the same category as such names [of herrings] as "Yarmouth Capons," and "Digby Chicks."

Crossing over to Italy and Greece, Pliny says, VII. 2 (1), that the Indians dwelling west of the Indus "know no food but fish"; IX. 22 (16), that "auguries are derived from fishes; IX. 80 (54), that after the death of L. L. Lucullus, surnamed Murena, from his love of that fish, the stock in his ponds sold for about £32,000; and IX. 80 (55), that the fish-pond of C. Hirrius was sold for a like sum,—instances of the many flagrant vulgarities that tainted, and at last undermined and overthrew "the grandeur that was Rome"; XXXII. 7 (2), that "in the Fountains of Jupiter at Labrauda [in Caria] there are eels which eat from the hand, and wear earrings; also at Chios, at the Temple of Old Men ['senum delubrum'] there; and at the Fountain of Chabura ['the Fountain of Juno'—*i.e.*, Atargatis, of XXXI. 22 (3)] in Mesopotamia"; XXXII. 8 (2), that, "at Myra, in Lycia, the fish in the Fountain of Apollo . . . give oracular responses, when thrice invoked by the sound of a flute . . . and that at Hieropolis [Bambyce, Mabug], in Syria, the fish in the Lake of Venus [Atargatis], bedecked with jewelry of gold, answer to the call of the temple attendants"; and XXXII. 10 (2), that, "Numa Pompilius forbade the serving up of fish without scales at the festivals of the gods . . . with the intention that banquets, both public and private, and the covers laid before the gods, might be more economically provided for the future; and also to preclude the risk of the caterers on such occasions forestalling the market, and raising the price of the fish required"; and Athenæus, after giving, I. 22, the names of eight writers on fish, says, III. 85, that the fish of all kinds caught at Byzantium were stated to be superior to all other fish taken elsewhere [in the Mediterranean and Euxine]; VII. 18, quotes from "the Telchinian History":—"What are called sacred fish are the Dolphin and Pompili" [compare Anglo-Indian Pomfret, and see Yule's "Glossary"]; himself adding, that "it is an exceedingly libidinous fish, sprung at the same time with Aphrodite from the foam of the sea [a euphemism for the matter that flowed from the mutilated Cœlus, or his son Saturn]"; VIII. 2, that in certain places where there is no overflow of rivers, small fishes are at times found in deeply dug ditches, as in Paphlagonia, where they are called "fossil fish"; VIII. 4, quotes from Theophrastus that there are in India fish that leap out of the rivers, on to their banks, and then back again into the water, "just like frogs"; VIII. 7, that when Sarpedon, the general of Demetrius, was, just after his defeat near Ptolemais by Tryphon, delivered from utter destruction by a sudden wave from the sea swallowing up his victorious enemy, he sacrificed incredible quantities of fish to Poseidon; VIII. 10, that Nemesis was metamorphosed into a fish; VIII. 36, that Apollo was honoured among the Eleans under the title of "Fish-Eater"; and that in the temple of Diana at Pisa, Neptune was represented as offering a parturient tunny to Jupiter; while in VIII. 37, he gives the following account of Atargatis: (1) from "Antipater of Tarsus, that among the Syrians," no one could eat fish without Gatis being invited [ἄτερ Γάτιδος], whence the common people, taking her name to be Atergatis, abstained altogether from eating fish; (2) from Mnaseas, that "Atergatis was a bad queen . . . and forbade fish to her people, because she had such an appetite for fish herself," and hence the custom still continues among the Syrians when praying to her, to offer her similitudes in gold and silver of fishes; and also real fish, daintily cooked, which the priests and the goddess eat themselves; and (3) from Xanthus the Lydian, that Atargatis, "being taken prisoner by Mopsus, King of Lydia, was drowned, with her son, in the lake [one of the holiest of her fish-ponds] near Ascalon . . . and was devoured by the fishes therein." My last extract, from Athenæus, shall be the irrelevant one of the last two lines of his quotation from Alexis, which I translate here, simply as an affectionate tribute to him as a learned and most truly companionable opsologist:—

"Eat fish, and drink like fish, to the full of your lust:—
Pericles, Codrus, Cimon, they all are but dust!"

It will be recalled also, and with sympathy, how the Children of Israel, when they went out ["on strike"] into the desert of Sin, soon "fell a-lusting" after "the flesh-pots of Egypt," "the fish which we did eat in Egypt freely" [Ex. xvi. 3, Num. xi. 4, 5]. It is also a suggestive fact that although most of the Greek words compounded of ὄψον, "a dainty," refer to dainties and dainty cookery generally, they would seem to refer especially, at least in ancient Athens, to fish and its cookery; thus, ὀψοπώλης is "a fishmonger," ὀψωνέω to "buy fish," ὀψωνία "purchase of fish," ὀψωνόμος, inspector of [prices of] fish," ὀψοφάγοι, "fish-eaters," and ὀψοφαγίστατοι, "fond fools after fried fish."

The vestiges of ichthyolatry to be traced in the remains of the ancient art of the West, although fewer than the evidences of it sequestered in our ancient literatures, are now better known than the latter, owing (1) to the wide circulation given during the past eighty years to the results of antiquarian research in Egypt, and Mesopotamia, and Anterior Asia, and Greece,—the figure, in particular, of the Euphratean Fish-man god so frequently seen on the cylinders [for sealing letters] of Babylonia and Assyria, being now familiar throughout Europe and America; and (2), to the perpetuation of the Fish-woman figure as a charm in the peasant jewelry of Southern Italy. The Greeks, with

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whom, in art, we must include the Romans, were instinctively repelled by the unnatural conventional and symbolical forms of the popular divinities in Egypt and Mesopotamia; the tendency of their genius having been to represent them by the most highly inspired artistic expression that could be given to natural forms, above all, to the human form, by the graver, the chisel, and the brush; until, for examples, their Zeus, and their Athene, were perfected to the realisation of the ineffable ideals of Homer and of Phidias. No Greek jeweler, sculptor, or painter, not even the depraved "pilferers of minium," and "painters of dirt" [πορνογράφοι], would have prostituted and degraded their art to the reproduction of such monstrous personifications of their greater gods, as the "Bull-headed Dionysos," the "Horse-headed" Demeter, and the "Horse-man" Poseidon; notwithstanding that the crude and repulsive archaic images of these divinities may have indefinitely continued to be venerated by the common herd of their worshippers. It was only the minor mythological beings that the Greeks ever rendered in the composite iconography of the original Oriental conceptions of them; and even then they refined them to the uttermost by the severest artistic draughtsmanship of their strange symbolical features, as in the instances of the Centaurs, Pegasus, Pan and the Satyrs, Scylla and Charybdis, Geryon and, if they may be added, the Chimæra, and the ever loathsome Harpies; while the sacred fishes appear in Greek art either, in their real and true shapes, like the Dolphin at the beautiful feet of statues of Aphrodite, and the dolphins circling the lovely head of the Nereid Arethusa, on the coins of Syracuse; or as the deformed Oriental presentments of them, transformed by deft draughtsmanship into such artistic conventions as of the other Nereid, Amphitrite, and of her father Nereus, and Triton, and the Sirens. These ichthyomorphs, issuing primordially from the banks of the Nile, and the Tigris and Euphrates, were carried by the "go-a-ducking Phœnicians," and later by the "merry Greeks," into every country bordering on the Mediterranean Sea, and under the Italian common name of *sirene*, and *cavalli marini*, are still to be found in use as talismanic trinketry through all the countryside about such old-world places as Palermo and Messina, Naples and Brindisi: while twice in the past forty years I have seen them in those wonderful shop windows of Regent Street, and Piccadilly, and Bond Street—whereof every student of comparative technology may truly say:—

"They are the books, the arts, the academies,
That shew, contain, and nourish all the world!"

If any reader of the *Journal* will compare these *sirene*, or *cavalli marini*, with the representation of the goddess Amphitrite on the mosaic floor, illustrated by Professor Dante Vaglieri in the paper on his archæological researches at Ostia, published in *Nash's Magazine* for last month [December, 1911], it will at once be recognised that the continuity of Greek art, at least in its "motives" and craftsmanship, is as marked among the peasantry of Southern Italy, as is that of Hindu art among the agriculturists of Southern India; and owing very much to analagous physiographical, and geographical and commercial, and political, and religious causes. But India alone still holds the living secrets of the hiero-typology of her art—Hindu art—and of the full significance of the sanctity of the fish; as these were first systematised by the priests and bards of all the historical races, Semites, Hamites, and Aryas, of the Old World, after they had advanced out of savagery [and totemism], into barbarism, toward joyous semi-civilisation [and poetical polytheism]: and for my own part I would rather ever remain a semi-civilised Pagan:—

"So might I standing on this pleasant lea,
Have glimpses that would make me less forlorn:
Have sight of Proteus rising from the sea,
Or hear old Triton blow his wreathed horn."

And as for the sunny "Fountains" of Venus [Aphrodite], great Apollo, Jupiter [Zeus], and Juno [Here], of which Pliny writes, the likes of them, reflecting the ever dazzling sun, flash everywhere like mirrors, over the whole far and widespread plains of India—India of the Hindus: and in Islam itself, the fishgarths before the mosque at Tripolis [Syrian], and the mosque at Edessa [Syrian], are the self-same "Fountains" frequented in the ancientmost days of Anterior Asia by the idolatrous Phœnicians. Among the photographs of the majestic Coronation Durbar at Delhi, published during the current month in the illustrated newspapers of London, one of the most impressive was of the serene and stately *Jama Masjid*, or Mosque, of that right imperial city, with the large square "tank" before it, filling the foreground; and, by a happy coincidence, in *The Wide World* for this month [January, 1912] Mr. J. H. Bell, British Consul at Shiraz, in his paper, entitled "Across Persia and Europe on Pony-back," reproduces, on page 387, a photograph of the shrine at Qumisheh, near Ispahan, with its tank of sacred fish before it. At leisure moments, learned Muslims will playfully feign, or possibly they accept it seriously, that "Jonah's Whale" [Atargatis], is at times to be seen, as in vision, basking in these tanks. Anyhow, Jonah is their Zu'n-Nun, "He of the Whale" [compare "Joshua, the Son of Nun," *i.e.* "Fish," or (Sea) "Serpent," "Oannes"]; and "Jonah's Whale," with the Ox on which Moses rode, and the Ass on which Balaam sat, and the Ass on which the Queen of Sheba rode when she visited King Solomon, and the Ass on which our Saviour rode into Jerusalem, are among the ten or twelve animals that, in the belief of all Muslims, are admitted into Heaven. The very name of the letter N, in Hebrew, Arabic, Greek, English, etc., is said, by Al Baizwai, to be derived from the name of "Jonah's Whale," that is Nun, which refers ultimately to Hea [Atargatis, etc.], and the abyss of waters out of which Oannes arose, somewhere about the vague site of "the Garden of Eden," and there laid the fast-bonded foundations of

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Mesopotamian industrial, artistic, literary, and religious culture. It seems indeed as if there could be nothing of this world—of the universe—that ever was, or is, or will be, that is not inextricably commingled with everything else, past, present, and future.

Having written so far, I have received a letter insisting on the anagramatic origin of the Christian Fish symbol, and protesting against its identification with "any heathen type." There can, however, be no gainsaying of this historical fact, and it is but one of many instances [see Count Goblet D'Alviella's "Migration of Symbols," edited, with an Introduction by myself: Constable] enforcing the truth so clearly and pithily expressed by St. Thomas Aquinas, in his great Hymn, "Pange lingua," in the verse beginning "Tantum ergo":—

> "Et antiquum documentum
> Nova cedit ritui":—

a hymn which, for spiritual insight, fervent feeling, and the music of its movement is unapproachable within the whole range of Latin Hymnology, unless only by Gladstone's devoutly impassioned translation of "Rock of Ages."

George Birdwood.

GENERAL NOTES.

Machinery for India.—Mr. Frederick Noel-Paton, who is the Director-General of Commercial Intelligence, India, sends the *Journal* a leaflet, in which he points out that India is now the largest single purchaser of machinery from England, but that the business might be largely extended if there was better co-operation between British makers of machinery. Many engineers in England make only part of the appliances required in a given industry. In Europe this matters little, for it is easy to find makers of complementary plant and consult them with a view to completing the requisite estimate. It is different in India. British firms send out travellers, who often fail to get orders because they can only quote for one part of the plant required, and Mr. Noel-Paton urges that through one channel or another full information should be given. In most cases the manufacturer knows what other appliances are required and what their power or capacity should be. "He knows where a suitable engine could be obtained and where—say—suitable crushers or centrifugals could be bought to complete the equipment. In such cases it would be sufficient if he dropped a line to the makers of the complementary plant, saying that a certain official wanted information about a plant for such-and-such an industry, stating that the writer was sending drawings and approximate quotation, and asking that his correspondent should forward similar information about such-and-such complementary appliances of corresponding capacity." In some foreign countries organisation and co-operation among manufacturers has been carried further than in England, and co-ordination between officials and manufacturers is more highly developed.

Agricultural Implement Trade of France.—During 1910, France imported 35,000 tons of agricultural machinery and implements to the value of 45½ million francs (£18,200,000), as compared with 37,000 tons and 48 million francs (£19,200,000) of the previous year. The greater part of this machinery came from the United States, Canada, Great Britain, Germany, and Belgium. The exports, on the other hand, were much less, being 7,400 tons, to the value of 48 million francs (£19,200,000) only. The principal customers for this class of machinery are: Algeria, Tunis, Italy, Switzerland, Spain, Turkey, Chili, and the Argentine Republic.

Consumption of Horse-flesh in Paris.—The consumption of horse-flesh in Paris appears to have increased rapidly from 1897 to 1907, when it reached its maximum; since then it has slowly decreased.

		Kilograms.
1897–1901	the average annual consumption was	5,513,000
1902–1906	" "	10,743,000
1907		14,893,000
1908		14,495,000
1909		14,184,000
1910		13,704,000

Of this last amount, equal to 13,496 tons, 12,197 kilograms were furnished by animals slaughtered in Paris and 1,507,000 kilograms were imported from other places. The total number of animals slaughtered last year at the abattoir for horses in Paris was 49,403, being 48,070 horses, 870 asses, and 463 mules. The average yield of meat per head was 246 kilograms (=542½ lbs.).

Production of Iron Ore in Spain.—Although Spain is a great producer of iron ore, the industry seems to be stationary, the output in 1909 being about the same as in 1899, while the other leading producers have been increasing their output by rapid strides. The failure of Spain to keep pace with the other nations in iron ore production is largely due to the growing scarcity of ore in the Biscayan iron zone. In 1909, in the province of Biscay, 3,870,000 tons of ore were mined, of which over three millions were exported. The provinces of Guipuzcoa and Navarre export yearly from 20,000 to 30,000 tons of ore by rail to France through the station of Irun, and about 75,000 tons by water to the United Kingdom and Germany from the port of Pasages. From the province of Santander 800,000 tons are exported annually. Further to the west, along the northern coast, are the ports of Rivadesella San Esteban, Ribadeo, Vivero, and Corunna, whose exports amount

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annually to 400,000 tons of phosphoric ores. Practically all the ore from southern Spain, 3,500,000 tons, is non-phosphoric, and thus adaptable for the manufacture of Bessemer steel. The total production of iron ore in Spain in 1909 was 9,384,634 tons.

SERICULTURE IN NORMANDY.—During the last few years silkworm rearing has been revived in Normandy, where it at one time was carried on to some extent. Since 1844 until recently the industry had almost entirely disappeared from the country. A circular has lately been issued by a committee of sericulturists drawing the attention of landowners and farmers to the advantages which might be derived from the planting and cultivation of the white mulberry tree as well as from the production of silk.

SALE OF GRAPES AT FONTAINEBLEAU.—The sale by auction of the grapes from the celebrated vinery of the "Treille du Roi" at Fontainebleau realised 3,374 francs (£135). The total weight of the crop, which was of a very fine quality, amounted to 1,475 kilograms (3,252 lbs.). The grapes, which were sold in fifty-nine lots of 25 kilograms (55 lbs.) each, fetched on the average 2·29 francs per kilogram (about 10½*d.* per lb.). This espalier, which measures 1,350 metres (1,476 yards) in length and 2½ metres in height (8 feet), was planted in 1531 by order of François I., King of France, and here originated the famous *chasselas* of Fontaineblean. The soil is deep, of a sandy nature, and the vines have an easterly and south-easterly aspect.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

JANUARY 24.—WILLIAM J. GEE, "Hydraulic Separating and Grading." ROBERT KAYE GRAY, M.Inst.C.E., will preside.

JANUARY 31. — PROFESSOR G. W. OSBORN HOWE, M.Sc., M.I.E.E., "Recent Progress in Radio-Telegraphy." SIR WILLIAM H. WHITE, K.C.B., F.R.S., will preside.

FEBRUARY 7.—LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

FEBRUARY 14.—CECIL THOMAS, "Gem Engraving." SIR ARTHUR JOHN EVANS, D.Litt., LL.D., F.R.S., will preside.

FEBRUARY 21.—FRANK WARNER, "Silk." SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

FEBRUARY 28.—H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry." PRINCIPAL SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 8. — COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India."

MARCH 14.—E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

APRIL 25.—WALTER SAISE, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

MAY 16. – NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

JANUARY 30.—W. A. LEGG, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony, "Irrigation in South Africa." The HON. SIR RICHARD SOLOMON, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, will preside.

MAY 7.—ALAN BURGOYNE, M.P., "Colonial Vine Culture."

MAY 21.—THE HON. J. G. JENKINS, "Australian Railways."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." Two Lectures.

Syllabus.

LECTURE I.—JANUARY 22.—The size and speed of ocean waves—The height of waves in lakes, seas, and rivers—The length of waves in lakes, seas, and rivers—The steepness of waves, and strains upon ships—The periodic time of waves, and the rolling of ships—The speed of waves and its relation to velocity of wind—The height of waves and its relation to velocity of wind—The time required to develop large waves, and the duration of storms—The length and speed of the swell observed after storms—The probable height of the swell during storms—The relation between the dimensions and path of a cyclonic depression and the nature of the winds produced—The depth in which waves break, and its relation to defence works.

LECTURE II.—JANUARY 29. — The action of waves and tidal currents on sea-beaches and sandbanks—The proper action of waves to drive

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sand and shingle shoreward—The proper action of waves to drive mud seaward—Special conditions under which the action on sand is reversed—The proper action of the tide to drive shingle in the direction of the flood—The normal removal of shingle from promontories and its accumulation in bays—The exceptional accumulation of shingle in salient positions, *e.g.*, at Dungeness—Groynes—The reason of the graded arrangement of shingle on the Chesil beach—The formation of a sandbank on the up-channel side of a promontory—Sandbanks in estuaries and their arrangement by tidal currents—Their rippled surface as a means of mapping these currents—Their influence on the formation of tidal bores—The struggle between land water and tidal water to arrange the sandbanks in the Severn—The variability of the Severn Bore as determined by these factors—The circumstances which determine the starting point of the Severn Bore.

LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." Three Lectures.

February 5, 12, 19.

LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 22...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. Vaughan Cornish, "Ocean Waves, Sea-Beaches and Sandbanks." (Lecture I.)

Sanitary Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Mr. L. W. Chubb, "Smoke Abatement."

Aeronautical, at the United Service Institution, Whitehall, S.W., 8.30 p.m. Dr. E. H. Hankin, "Bird Flight."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. C. Rogers, "An Evening in the Institution Library."

British Architects, 9, Conduit-street, W., 8 p.m. Sir Alfred East, "Colour Decoration."

Victoria Institute, 1, Adelphi-terrace House, W.C., 4.30 p.m. Mr. E. W. Maunder, "The Conditions of Habitability of a Planet, with special reference to the Planet Mars."

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. L. Binyon, "Chinese Art."

TUESDAY, JANUARY 23...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on following papers: Mr. Somers Howe Ellis, "Reinforced-Concrete Wharves and Warehouses at Lower Pootung, Shanghai." Mr. W. C. Popplewell, "The Direct Experimental Determination of the Stresses in the Steel and in the Concrete of Reinforced-Concrete Columns." Mr. W. H. Burr, "Composite Columns of Concrete aud Steel." Mr. Richard John Durley, "The Central Heating- and Power-Plant of McGill University, Montreal."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Dr. T. Miller Maguire, "The New Pacific."

WEDNESDAY, JANUARY 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William J. Gee, "A New Process of Hydraulic Separating and Grading."

Geological, Burlington House, W., 8 p.m.

Economics, London School of, Clare-market, W.C., 5 p.m. Mr. Ben Morgan, "The Trade, Industry, and Finance of the British Empire."

United Service Institution, Whitehall, S.W., 3 p.m. Mr. G. Renwick, "Our Food Supplies in Time of War."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Mr. Howard Candler, "Lucian and his Times: the Underflow of Christianity."

THURSDAY, JANUARY 25...London Institution, Finsbury-circus, E.C., 6 p.m. Dr. Vaughan Cornish, "Waves of the Sea."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Bickerton, "The New Astronomy." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8 30 p.m. Mr. A. Keighley, "Pictures of Italy."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Messrs. Miles Walker and H. D. Symons, "The Heat Paths in Electrical Machinery."

FRIDAY, JANUARY 26...Royal Institution, Albemarle-street, W., 9 p.m. Professor B. Hopkinson, "The Pressure of a Blow."

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, JANUARY 27...Royal Institution, Albemarle-street, W., 3 p.m. Rev. John Roscoe, "The Banyoro; a Pastoral People of Uganda." (Lecture II

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Journal of the Royal Society of Arts.

No. 3,088. VOL. LX.

FRIDAY, JANUARY 26, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 29th, 8 p.m. (Cantor Lecture.) VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." (Lecture II.)

TUESDAY, JANUARY 30th, 4.30 p.m. (Colonial Section.) W. A. LEGG, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony, "Irrigation in South Africa." The HON. SIR RICHARD SOLOMON, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, will preside.

WEDNESDAY, JANUARY 31st, 8 p.m. (Ordinary Meeting.) PROFESSOR G. W. OSBORN HOWE, M.Sc., M.I.E.E., "Recent Progress in Radio-Telegraphy." SIR WILLIAM H. WHITE, K.C.B., F.R.S., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, January 22nd, MR. VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., delivered the first lecture of his course on "Ocean Waves, Sea-Beaches, and Sandbanks."

The lectures will be published in the *Journal* during the summer recess.

LIST OF MEMBERS.

The new edition of the List of Members of the Society is now ready, and can be obtained by Members on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Members wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s.* 6*d.* each, on application to the Secretary.

THE ROYAL SOCIETY OF ARTS.*

By SIR HENRY TRUEMAN WOOD, M.A.,
Secretary of the Society.

VI.—THE PREMIUMS.
(1754–1851.)

Concluded.

Dollond's invention of the achromatic telescope in 1758 (for even if he was anticipated by Moor Hall, Dollond was an original inventor) rendered necessary the production of glass, especially flint glass, of great purity, perfectly homogeneous and free from striæ. Not only was improvement in the quality of the glass required, but large discs were wanted for astronomical refractors. With this object the Society offered prizes for optical glass in 1768. Two such prizes were proposed—one of £60 for a sample of optical glass, not less than 20 lbs. in weight, "fit for those purposes for which flint glass is used in achromatic telescopes," and a second of £20, for glass "suitable for the general purposes of opticians." The minutes of the committee at which the proposal was discussed do not give any further particulars, nor has any record been found to show with whom the proposal originated. It is possible that the committee hoped to obtain glasses which in combination would prove achromatic for all the colours in different parts of the spectrum, and so to get rid of the "secondary spectrum" or "residual dispersion," which can never be entirely abolished by the use of two kinds of glass only, though the Jena factory has recently produced glasses which go near the attainment of this end. It is also evident, from the stipulated weight of the specimen, that the committee had in view the production of larger discs than could at the time be manufactured. At all events, the committee wisely drafted their proposal in very general terms, so as to cover any possible improvements in the manufacture.

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, November 3rd, 1911, and January 12th and 19th, 1912.

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Two prizes were awarded—£30 to Abraham Pelling, in 1770, and £40 to Richard Russell, in 1771—but no practical result followed, and the offer of prizes was not continued after 1779.

It was indeed many years before the need was supplied. The French Academy also offered prizes for perfect discs of optical glass, but without any better success than the Society of Arts. The first to produce such discs was Pierre Louis Guimand, a Swiss watchmaker, about 1790. He was afterwards (1805) associated with Fraunhofer, and on his discoveries are based all the great modern improvements in the production of large discs for refracting telescopes. For any great improvement in the character of the glass itself we have had to wait till our own times, since it is only within the last twenty years that the Jena laboratory has furnished the makers of optical instruments with glasses in which high refractive power is combined with low dispersion, and high dispersive power with lower refractivity.

Henry Baker, the microscopist, was one of the founders of the Society, but this does not seem to have led him to propose any premiums for improvements in the microscope. Nor, indeed, had any such offers been made, could they have had much practical result, since it was not until the achromatic object-glass had been perfected that the modern microscope came into existence. Fraunhofer seems to have been the first to make an achromatic objective of any practical use (about 1816), and this was very imperfect, for five years later (1821) M. Biot expressed the opinion that "opticians regarded as impossible the construction of a good achromatic microscope."* Dr. Wollaston also thought that "the compound microscope would never rival the single." However, in 1824, satisfactory objectives were independently produced by Chevalier, in Paris, and by Tulley, in London, and the development of the microscope went on apace. The use of high powers necessitated the provision of rigid stands, and gradually led to the invention of the various mechanical devices for accurate focussing, and for imparting minute movements to the object, as well as all the other details of construction, which have brought the instrument to its present perfection. In the third, fourth and fifth decades of the nineteenth century, prizes for various improvements in the microscope were awarded to Varley (1831), Powell (1835 and 1841), Goadby (1835), and Ross (1837). The *Transactions* about the same time contain other communications on the subject. Hogg, in his book above referred to, attributes the Society's action to the influence of Mr. Edward Solly, who, he says, "has been the means of making its *Transactions*, since 1831, the vehicle through which nearly all the improvements in the construction of telescopes and microscopes have been made known to the world."*

* "The Microscope," Jabez Hogg (1855), p. 8.

In 1782, a gold medal was offered for "a cheap and portable transit instrument which may easily be converted into a zenith sector, capable of being accurately and expeditiously adjusted for the purpose of finding the latitudes and longitudes of places." This prize was continued till 1819, but without any result. The transit instrument was invented in 1690 by Olaus Römer, the great Danish astronomer, who was the first to measure the velocity of light by observing the eclipses of Jupiter's satellites. The first transit instrument was set up at Greenwich in 1721. It is not very obvious why this prize should have been offered, except that the great improvements in accurate timekeepers, resulting from the work of Harrison, Arnold, and the other skilful chronometer-makers of the time, rendered possible the use of more accurate astronomical instruments, and thus created a demand for them.

In 1774, a gold medal was offered for an invariable standard of weights and measures, and it was pointed out in the notice of the offer that previous suggestions for the determination of a standard by means of the pendulum had not been successful. The first of these suggestions was made by Picard, in 1671, who proposed that a pendulum beating seconds should be employed, and that one-third of its length should be adopted as the standard foot. Nevertheless, the only two candidates who received any awards both proposed to use the pendulum, and both submitted devices which could only give results of moderately approximate accuracy. One of them, Hatton, a watchmaker, who received thirty guineas in 1779, speaks of his apparatus as correct to the twentieth of an inch, though he proposes to employ an adjusting screw to ensure even greater accuracy! Fifteen years later, in 1794, Dr. More, the secretary, submitted a communication to the Society,† in which he very sensibly deprecates a reference to natural constants for the construction of a standard, and proposes the accurate copying of the then existing pound, preserved at the

* *Op. cit.*, p. 11.
† *Transactions*, Vol. XII. p. 292.

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Exchequer. It seems likely that More was led to publish his paper by the attempts then being made by the French National Assembly to fix on a theoretical standard. In 1790 they passed a decree adopting a system of measures based on the seconds pendulum, but in the following year they abandoned the pendulum, and decided to base their standards on a quadrant of the meridian. When the Republic was proclaimed this proposal was confirmed, and the one ten-millionth part of the arc of the meridian from the Pole to the Equator, was, as is well known, declared to be the metre or standard of length for France.

Dr. More really anticipated the course of our own legislation on weights and measures, which has simply ordained the accurate copying of certain ancient examples, and has declared that these copies are the actual standard weights and measures of the country. Practically the French Government have had to do the same thing, for the metre is not a fractional part of the earth's meridian, but the length of a certain platinum bar, preserved in Paris, just as our yard is the length of a certain bar (or rather the distance being certain marks on that bar) preserved in London.

The premium was only continued for a very few years. It is exceptional, inasmuch as it was open to "persons residing in any country whatever." Had the prize been continued for another 120 years or so, it would therefore have been available for the very beautiful suggestion, made about seventeen years ago by Professor A. A. Michelsen, that the length of the metre might be stated in terms of the wave-lengths of red light.*

In 1777, a gold medal was offered for a method of measuring "the degrees of sweetness in saccharine substances." This does not seem to have meant a saccharometer, but some means of establishing a standard of sweetness. Nothing came of this offer, which was continued for some time, and then abandoned, nor is it conceivable that such a standard could be set up. It was soon after this, in 1784, that the brewer's saccharometer was first introduced by Richardson. of Hull. It was a form of Martin's hydrometer, which indeed had been used in brewing in 1768. It had a scale adapted for the use of brewers, and was indeed merely a hydrometer which indicated the difference between water and wort, water containing a percentage of saccharine matter. Richardson's calculations are said not to have been quite correct, but sufficiently so for practical purposes.

* "Valeur du mètre en longueurs d'ondes lumineuses." Paris (1894). Chaney's "Weights and Measures" (1897), . 23.

The hydrometer in its modern form was described by Robert Boyle in the *Phil. Trans.*, 1675. It remains the same in principle, but has been improved in details, and has been fitted with weights and various scales to adapt it to liquids of different specific gravities. In 1771, a prize was offered for an instrument to measure the strength of spirit, and in 1781 a silver medal was awarded to Matthew Quin for his hydrometer. In 1790, a second silver medal and twenty guineas were given him for an improved instrument, the principal feature of which was a sliding scale to adapt it to different temperatures. Other awards were made, the latest in 1820, but Quin's appears to have been the most important instrument recognised by the Society.

Two gold medals were at different times awarded to the eminent mechanical engineer, Bryan Donkin; one, in 1810, for his tachometer, and one, in 1819, for his counting machine. Mr. Donkin was for long a Vice-President of the Society and Chairman of its Committee on Mechanics. He was the leading mechanician of his time, and was best known for his share in the completion and construction of Fourdrinier's paper-making machine. It can hardly be doubted but that he would have received some recognition for this also from the Society, if the machine had not been the subject of a patent.

The tachometer was so named by himself, and was intended, in his own words, "for indicating the velocity of machines." According to the description in the *Transactions*,* it was meant to indicate the varying velocity of machines rather than to measure their speed. This it did by means of a rotating cup filled with mercury, to which motion was given from some part of the machine. The spinning of the cup causes the level of the mercury to sink at the centre and to rise at the rim. The variations of level were indicated by the rise and fall of a column of spirit in a glass tube, the lower end of which was immersed in the mercury.

The counter would appear to be the original form of the now well-known device in which a train of wheelwork indicates on a series of dials for units, tens, etc., the revolutions of any spindle. Two arrangements are shown, both working by ratchet-gear, and indicating by clock-hands on a single dial.†

* *Transactions*, Vol. XXVIII. p. 185.

† *Ibid.*

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The award in 1825 of a silver medal and thirty guineas to W. Sturgeon, for "Improved Electro-Magnetic Apparatus," is of extreme interest, because the account of his apparatus contributed by Sturgeon to the *Transactions*,* proves him to have been the inventor of the electro-magnet. The whole subject has been very carefully worked out by Professor Silvanus Thompson,† who quotes a letter from Dr. Joule to Mr. Angus Smith, in which that great philosopher says:—"I have sifted Mr. Sturgeon's claims to the utmost. I have examined all the periodicals likely to throw light on the history of electro-magnetism, and find that Mr. Sturgeon is, without doubt, the originator of the electro-magnet, as well as the author of the improved electro-magnetic machine. The electro-magnet described by Mr. Sturgeon in the 'Transactions of the Society of Arts for 1825' is the first piece of apparatus to which the name could with propriety be applied. . . . To Mr. Sturgeon belongs the merit of producing the first electro-magnet constructed of soft iron."

Dr. Joule also states that Sturgeon was "without doubt the constructor of the first rotary electro-magnetic machine," the inventor of the commutator, and the first to use amalgamated zinc plates in batteries.

Professor Thompson reproduces the pictures of Sturgeon's electro-magnets from the *Transactions*, and expresses the regret which all interested in the subject must share, that the actual instruments, given by the inventor to the Society's museum, have not been preserved. He also, in an appendix, gives a very full account of Sturgeon's life and researches. Like so many other inventors, Sturgeon never received in his lifetime either the recognition or the reward he deserved. After his death his discoveries were utilised and developed by his successors, whose increased knowledge enabled them to realise the value of researches which his contemporaries were not sufficiently well-informed to appreciate.

Two years previously, in 1823, an identical award had been made to James Marsh, the chemist, who devised the well-known test for arsenic still associated with his name, and with whom Sturgeon had been for some time associated. In the note appended to Sturgeon's communication to the *Transactions*, attention is drawn to several points in which Sturgeon's apparatus is considered superior to that of Marsh.

* Vol. XLIII. p. 37.

† "The Electromagnet," by Silvanus Thompson, F.R.S. (Second Edition, 1892), pp. 2-9, and Appendix A, p. 412.

The award of a gold medal in 1840 to Alfred Smee for his galvanic battery was certainly well deserved. A convenient source of electrical energy was then much wanted, and Smee's cell was a great advance on all its predecessors. It was fairly constant, moderately cheap, of high electro-motive force, free from fumes, and readily put in and out of action without loss or waste.

The negative element was a thin sheet of platinised silver, the platinum being deposited as a fine adherent powder on the surface of the silver, which had previously been slightly roughened. This plate was supported in a light wooden frame between two zinc plates which formed the positive element. The exciting fluid was diluted sulphuric acid.

Smee's battery came into very general use for experimental work, and was for long used and greatly appreciated. A well-known and popular writer on electrical matters said, in 1875, after the battery had been in use for over thirty years, that it was "one of the most valuable gifts ever made to electrical science."*

The now universally used method of obtaining a conducting surface for electro-deposition by means of plumbago was the discovery of Robert Murray, and for it he received a silver medal and ten pounds in 1841. In his paper in the *Transactions*,† he says that Edward Solly was the first to obtain a conducting surface on a non-conducting material by the use of nitrate of silver, and he goes on to describe his own process, which is identical with that now used. In fact, the instructions he gives describe in every detail the present method.

In the later volumes of the *Transactions* are to be found descriptions of a great variety of instruments which received rewards of different value from the Society. Many of these are obsolete, many contain the germs of appliances since improved and perfected, some are now familiar. Drawing instruments, "perspectographs," etc., are numerous. Amongst these may be mentioned the ordinary child's "transparent slate," which now common toy received a gold medal in 1814, as a valuable means of teaching writing. There are several ellipto-graphs (including those devised by Farey, Cubitt, Clement, and Hicks), Ross's first spherometer (1841), with a central axial sliding rod, mounted in a truly-turned supporting ring, afterwards perfected by the substitution for the ring of a frame with three supporting points. Surveying instruments, sextants, and their predecessors,

* J. T. Sprague, "Electricity" (1875), p. 91.

† Vol. LIII. p. 10.

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quadrants and octants, appear in the lists. Surgical and dental instruments are also fairly numerous. The list is a very long one. As to the value of its contents, only an expert in each class could speak with confidence, but its immense variety, at all events, bears testimony to the catholicity of the Society's objects and operations in the first half of the nineteenth century.

After the application of gas for illuminating purposes by Murdoch in 1792, we find a few prizes offered and awarded for improvements connected with gas-lighting.

In 1797 a prize was offered for a "substitute for tar," but though the offer remained open for many years, it does not seem to have attracted any competitors. This is remarkable, because the production of tar from coal had been known and practised for a considerable period. In 1681 letters patent had been granted to John Joachin Becher and Henry Serle for "a new way of makeing pitch and tarre out of pit coale." These inventors were followed by several others, amongst them the Earl of Dundonald, who had a patent for obtaining tar and other products from coal.

In 1810, B. Cook, of Birmingham, describes a process for the distillation and utilisation of gas-tar, which he said was at the time a waste product, though considerable amounts were made in the production of gas, and the coking of coal.* The tar, Cook stated, was superior to the "common tar" for paying ships' timbers. The more important part of the communication related to a method of distilling the tar, from which a "liquor or volatile oil" (light oil) was obtained, and a "residuum" (pitch) "equal to the best asphaltum." He had varnish made from the pitch and the light oil, and sent in a sample of work treated with the varnish. For this paper, which was certainly among the early practical proposals for the utilisation of the by-products of gas-manufacture, Cook received the very inadequate reward of a silver medal.

Cook, however, had been anticipated by Winsor, whose patent specification of 1804 refers to the production and utilisation of various by-products from gas-making. Still, Cook's paper is full of interest, as he appears to have been an original worker and to have achieved a considerable measure of practical success.

In 1808 a silver medal was given to Samuel Clegg "for his apparatus for making carbonated hydrogen gas from pit coal, and lighting factories therewith." The apparatus included a gas-holder of the form now generally employed, of which Clegg was apparently the inventor. He was apprenticed to Boulton and Watt, and was in business in Manchester as a builder of steam-engines. He was the inventor of the gas-meter, which he patented in 1815, but (probably because it was the subject of a patent) he did not submit it to the Society. In 1819 a gold medal was given to John Malam for improvements on Clegg's original meter.

* *Transactions*, Vol. XXVIII. (1810) p. 73.

It is worth mention that the well-known telescopic gas-lamp, or chandelier, which is in common use up to the present date, was invented by William Caslon, who received a silver medal for it in 1817. The drawings in the *Transactions** show a chandelier identical with the most modern form, with sliding tubes, water-seal and counter-balance weights.

In the year 1802, a gold medal and a grant of fifty guineas were given to Henry Greathead, of South Shields, for the invention of the lifeboat. There seems very little doubt that Greathead was the builder of the first practical lifeboat, but it is uncertain how far the actual invention was due to him. The subject has been very carefully and exhaustively worked out by Sir John Lamb in a paper on the lifeboat, which he read before the Society in 1910.† In 1785, Lionel Lukin, of Long Acre, took out a patent for an "unimmergible boat." Nothing very much seems to have come of Lukin's invention, though in the year that he took out his patent he converted a coble into a safety-boat, which was afterwards employed at Bamburgh, Northumberland, in saving life from shipwreck. Lukin's boat was fitted with a cork gunwale and airtight cases at the end. Another inventor was William Wouldhave, of South Shields.

In April, 1789, the Brethren of the Newcastle Trinity House had before them a proposal to station a boat permanently at the mouth of the Tyne, for the saving of shipwrecked persons. A committee was appointed to consider suggestions for the construction of a suitable boat, and to this committee both Wouldhave and Greathead submitted models. Neither was adopted, but Greathead, who was a skilled boat-builder, was instructed to build a boat, which he seems to have done, partly carrying out his own ideas and partly those of some of the members of the committee.

The various claims of the three inventors have long been the subject of discussion, and are never likely to be settled. But it is clear that Greathead's was the first practical lifeboat, and

* Vol. XXXV. p. 162.
† *Journal*, Vol. LVIII. p. 354.

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the credit of its construction may be allotted to him. Besides the awards from the Society, Greathead received a grant of £1,200 from Parliament, 100 guineas each from the Trinity House and from Lloyd's, besides various other rewards.

A little earlier than this, attention had been directed to means of saving life from shipwreck by methods for effecting a communication between stranded ships and the shore. In 1792, the Society had given a "bounty" of fifty guineas to John Bell (then a sergeant, but afterwards a lieutenant, in the Artillery), for a method of throwing a rope from the ship to the shore.* But a great improvement upon this was brought before the Society sixteen years later, when Captain Manby received a gold medal† for his device for establishing communication from the shore to a stranded ship by the use of a mortar by which a line was thrown. The apparatus itself was devised in 1807, and was successfully used in the following year at the wreck of the brig "Elizabeth." It had previously been reported upon favourably by the Board of Ordnance, and before many years were over it was in extensive use all round the coast. After some twelve years' experience, the invention had been used so successfully, and had saved so many lives, that a Committee of the House of Commons recommended a payment to Manby of £2,000. The invention is still widely used in this and in other countries, but for many years past rockets have been substituted for the original mortar.

Other inventions of the same character were also rewarded by the Society about the same time, but none of them have stood the test of experience in the same way as Manby's well-known apparatus.

In 1776, a silver medal was given to Shipley, the originator of the Society, for a lighted buoy for saving life at sea. As the invention does not seem to be either specially valuable or remarkably original, it may, perhaps, be assumed that a certain friendliness of feeling dictated the award, as respect for his memory may have led to the publication of a description of the apparatus in the *Transactions* ‡ a few years after the inventor's death. A similar feeling may justify its mention now.

In the last half of the eighteenth century a great number of county maps were published. Their issue may without much doubt be traced to the offer by the Society of a prize of £100 for the map of any county on the scale of an inch to the mile. In justification of this statement it may be said, that, of the county maps mentioned by Gough in his great work on British topography, published in 1780, as being issued or in hand at that date, nearly all appear to be of a later date than 1762; and the same may be said of a list of such maps, which has been most obligingly placed at the disposal of the writer by Sir H. George Fordham, the great authority on this subject. Speaking of the survey of Yorkshire, which was carried out by Thomas Jefferys, the well-known cartographer, Gough says: "Jefferys undertook this, and other such surveys, in consequence of a premium of £100 offered by the Society of Arts for a county map." Jefferys died in 1771; this may account for his never having received a premium. After his decease the map was purchased and published by Robert Sayer.

This prize of £100* was first offered in 1759, though it was not included in the regular premium list before 1762. To avoid needless competition, a special announcement was made that the Society would accept an offer for the production of each map, and would afterwards pay the premium when the map was completed to its satisfaction. The first offer accepted was for a map of Dorsetshire by Isaac Taylor. This was published in 1765, and is described by Gough as a capital survey of the county, but he adds: "This, though the most particular, is very faulty in the place names." Whether on this account or for other reasons, no award was made to Taylor. There was some correspondence with him, and the last entry is in December, 1765, when the consideration of his map was "postponed." The first actual award was to Benjamin Donn, who in 1765 received £100 for his map of Devonshire. This was engraved by Jefferys.

The offer of prizes was continued in various terms up to 1801, after which it does not appear in the premium list, though awards were made as late as 1809. Smaller amounts than the original sum of £100 were sometimes paid, and in some cases medals were given instead of

* *Transactions*, Vol. X. p. 203; Vol. XXV. p. 135.

† *Ibid.*, Vol. XXVI. p. 209.

‡ Vol. XXV. (1807) p. 94.

* It was, however, but a small contribution to the actual expenditure on the production of such maps, if we are to rely upon the statement contained in Gough's notes on Sussex, in which a projected map of that county on a scale of two inches to a mile, in eight large sheets, is referred to as estimated to cost more than £2,400 for surveying, drawing and engraving, and to take six years in execution, four hundred subscribers at six guineas for the whole map being asked for.

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money prizes. In all, an amount of £460 was expended, besides four gold medals, three silver medals, and a silver palette. Maps were obtained of the following counties:—

Devonshire (1765)	Hampshire (1793)
Derbyshire (1767)	Sussex (1796)
Northumberland (1773)	Oxfordshire (1797)
Leicestershire (1778)	North Wales (1802)
Somersetshire (1783)	Cardiganshire (1804)
Suffolk (1784)	Shropshire (1809)
Lancashire (1787)	

Many of these are mentioned in Gough.

For the map of Derbyshire P. P. Burdett received £100. This map was said to have been produced under the direction of the Rev. John Prior, of Ashby-de-la-Zouch, who himself received a silver medal and twenty guineas in 1778, for a map of Leicestershire, which was really made by J. Whyman, an assistant of Burdett, and was published in 1777. Burdett also produced maps of Cheshire and Lancashire.

William Faden, who received £50 for a map of Hampshire in 1793, and a gold medal for one of Sussex in 1796, was a well-known map-maker. He afterwards presented to the Society a number of county maps which he had produced.

John Cary (whose name is given as Carey in the list) received a gold medal in 1804 for his map of Cardiganshire. This engraver and map-seller is best known as the publisher of the "New Itinerary," a road-book which ran through eleven editions, 1798 to 1828, but he, and his successors, G. and J. Cary, engraved and published between about 1769 and 1850 a very large number of maps, atlases, and topographical works.*

The map of Northumberland, for which in 1773 Lieutenant Armstrong received fifty guineas, is said to have been a capital map. It was engraved by Kitchin in 1769. Lieutenant (afterwards Captain) Armstrong was a son of an earlier map-maker of repute, Captain Armstrong.

Besides the Society's prize maps, a good many other county maps were issued. The *Transactions* for 1801† gives a list of twenty-six such maps of English counties in the possession of the Society, and some were afterwards added. In all, about fifty seem to have been produced, besides the great series issued by the Greenwoods (1829–34).

In 1802 the Society offered three gold medals for mineralogical maps of England, Ireland, and Scotland. Each map was to be on a scale of not less than ten miles to the inch, "containing an account of the situation of the different mines therein, and describing the kinds of minerals thence produced."

It is not reported that any of these medals were awarded; but the offer had the important result of assisting William Smith to publish his great geological map of England and Wales.*

William Smith is known as the father of British geology. As Canon Bonney says of him, in his life in the "Dictionary of National Biography," "he found the key to stratigraphy—viz., the identification of strata by their fossil contents." Though a well-known and successful canal engineer (he received a medal from the Society in 1805 for draining Prisley Bog), he was a poor man, and had great difficulties in publishing his map. He was assisted by the Society with £50, and his map of England and Wales and part of Scotland—in fifteen sheets, measuring 8 ft. 9 ins. high by 6 ft. 2 ins. wide, and on a scale of five miles to the inch, with geological colouring—was engraved and published by John Cary on August 1st, 1815, with a dedication to Sir Joseph Banks, P.R.S. It was accompanied by a memoir to the map (London, 1815, 4to), also published by Cary, who, in addition to stratigraphical tables issued in 1816 and 1817, published a series of six detailed geological sections across various parts of England (1817–19) and also, between 1819 and 1824, twenty-one out of the full number of the county maps in his large folio atlas ("Cary's New English Atlas," 1809), with Smith's geological colouring and marginal notes on the strata.

In the same year (1802) as that in which the prizes for mineralogical maps were offered, the Society also offered a gold medal for a "Natural History" of any English or Welsh county. This was to be really an account of the natural resources of the county, "so that the public may be enabled to judge what arts or manufactures are most likely to succeed in such county." This information was more effectively provided by the "Statistical Surveys" of the counties, published by the Board of Agriculture. The first of these is dated 1793, so the offer of the Society seems rather superfluous.

In 1803 the Society gave fifty guineas to R. Horwood for his map of London. Some sheets of the map had previously been submitted, in 1791, but the Society declined to

* See "John Cary, Engraver and Map-seller," a paper by Sir H. G. Fordham, read in 1909 (December 6th) to a meeting of the Cambridge Antiquarian Society, and published in pamphlet form. Cambridge, 1910, 8vo.

† Vol. XIX. p. 43.

* An "explanation" of the map and some most interesting "observations" by Smith, are given in the *Transactions*, Vol. XXXIII. (1815) p. 51.

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make any award to the work in its incomplete state, though they passed a vote of thanks to the author. There had been a number of maps of London published since Ralph Aggas issued what is believed to be the first map of the sort somewhere about 1560. Horwood's map was certainly a considerable advance on any of its predecessors, and more elaborate than any of them. It was one of the few maps of London made from an actual survey, carried out, as he says, by Horwood himself. All the houses are numbered, and it is stated that the publication of Horwood's map led to the general adoption of numbering, which had previously only been applied to a few streets. This statement, however, does not seem to rest on any very good authority. Not a great deal is known about Horwood. He was surveyor to the Phœnix Fire Office. It is said he produced his map for the use of that office, but he makes no reference to this in the letter from him printed in the *Transactions*.*

Although no actual award, beyond the thanks of the Society, was made to Messrs. Perkins & Co. for their description in the *Transactions*† of their process of steel-engraving for bank-notes, it is too interesting to be passed over. This absence of any award is doubtless due to the fact that the process was in use in America and by private English banks. It was afterwards applied to the production of postage stamps, when the introduction of the Penny Post in 1840 caused a demand for a large number of identical stamps.‡ Jacob Perkins, the principal of the firm, was a very ingenious inventor, and received several gold and silver medals from the Society. An American by birth, he passed much of his life in England. He was a pioneer in the use of high-pressure steam, and in this he was followed by his son, Angier March Perkins, and his grandson, Loftus Perkins, the last-named of whom built several of the first high-pressure steam-engines, and suffered the usual fate of those who are in advance of contemporary ideas.

In the "siderographic process," as it was termed, a soft steel roller was rolled to and fro over the surface of an engraved steel plate, until the design was transferred to the roller, which was then hardened, and used to produce other steel or copper plates. From these, impressions could be taken on paper in the usual way. As any number of these duplicate plates could be obtained, it was possible to produce as many identical paper prints as could be required. In the case of bank-notes, it was proposed that several artists of repute should be employed, each to produce a small vignette. All these vignettes were to be transferred to a single plate, on which also engine-turned patterns might be engraved. Thus prints, both artistic and complicated, would be produced, which certainly it would be beyond the power of any forger to copy, before the invention of photography.

From the commencement of the eighteenth century the paper industry had been developing, but it was chiefly concerned with the production of low-class papers. In the finer qualities English manufacturers could not compete with the productions of French and Italian mills.

The "export of paper in 1775 by Whatman seems to mark a turning-point in English paper-making. . . . Between 1754 and 1782 the Society of Arts was endeavouring to promote the manufacture of high-class paper in this country by the award of premiums and medals for the production of paper for copper-plate printing. The manufacture of silk-rag paper and of embossed and marbled paper also engaged its attention." *

As Mr. Rhys Jenkins says, many prizes were offered at different times for paper and paper-making materials, and these were continued for many years after the date he mentions. The first was the prize offered in 1757 for paper for copper-plate printing, and one of the latest that proposed, in 1830, for methods for manufacturing paper equal to China paper. At an early date an earnest attempt was made to obtain materials for paper other than rags, and a prize was offered in 1790 for paper from raw vegetable substances. In the announcement of this it was stated that the Society already possessed specimens of paper made from "thistles, potatoe haum, poplar, hop binds, etc." This offer was continued for thirty years without any addition being made to the list of materials, but it possesses a good deal of interest, because it was an intelligent anticipation of the course of future progress. Now, of course, practically all paper is made from "raw vegetable substances," that is to say, from cellulose which has not already been made up into some textile material. The volume of *Transactions* for 1823–4 (Vol. XLII.) was printed upon paper which, it is stated in a note, was made from "pure flax." The paper is good and is in excellent condition now, which is more than can be said for the paper of many of the volumes.

* Vol. XXI. (1803) p. 311.
† Vol. XXXVIII. (1820) p. 47.
‡ "Sir Rowland Hill and the History of Penny Postage." By G. Birkbeck Hill, 1880, Vol. I. p. 407.

* See article on "Paper-making in England (1714–1788)," by Rhys Jenkins; *Lib. Assoc. Record*, IV. pt. 1 (1902), pp. 135 and 136.

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It was really not until about 1860 that paper materials other than rags were generally used. About that time esparto began to be employed to a considerable extent. In 1856, fifty tons of esparto were imported, and perhaps this may be taken as the beginning of its application to the extensive manufacture of paper.*

It is rather remarkable that so little was done by the Society for printing, in connection with which there are practically no awards of any importance. Perhaps the most interesting entry in this class is that of the gold medal awarded, in 1819, to Aloys Senefelder as the inventor of lithography. The Society was a little behindhand in this award, for the process had been perfected by the inventor in 1798.

The justification for the medal being given at this time was no doubt the fact that in the year 1818 Senefelder published his "Lehrbuch der Steindruckerey," and that it was this book that really drew attention to the new art, though before this date lithography had been applied to artistic purposes. The first dated English lithograph is a reproduction of a pen drawing by Benjamin West, P.R.A. It bears the date 1801, and was published with other similar plates by Fuseli, Barry and others in 1803.†

Senefelder was much gratified with the award, and he sent to the Society, through Mr. Ackerman, one of his lithographic presses. In the same year that Senefelder was thus honoured, a silver medal was awarded to C. Hulmandel "for a lithographic drawing," and in 1829 Joseph Netherclift received £20 "for his improved methods of making lithographic transfers."

In 1793 an application was made to the Society by some of the principal London basketmakers, which stated that their business was almost at a stand for want of osiers, because "great quantities of these twigs had annually been imported from France, and all intercourse with that country being stopped, a sufficient quantity, the growth of England, could not be obtained." As a consequence of this a great number of the workmen had been thrown out of employment. A number of prizes for planting osiers were offered, and the result was very satisfactory. Many landowners started osier plantations, and numerous prizes were awarded, including a gold medal in 1797 to Lord Brownlow, so that in 1806 the Society was able to announce that its object had been accomplished, and a sufficient supply of English osiers provided. The offer of prizes was consequently discontinued.*

It does not appear to be known with any certainty when the straw-plaiting industry was first introduced into England; but it was certainly established at Luton and Dunstable by the middle of the eighteenth century. A little later the Society did a good deal to encourage it. In 1762 and the three following years a number of small premiums were given for "chip hats like the Italian," and at the same time prizes were offered for straw hats like those made at Leghorn; but without any result. In 1805 a gold medal was awarded to William Corston for making straw-plait similar to the Leghorn plait from rye straw grown in Norfolk.† Again, in 1822, a silver medal was given to John Parry for the manufacture of Leghorn plait from straw imported from Italy. In the same year a silver medal was given to Miss Sophia Woodhouse, of Connecticut, U.S.A., for a new material for straw-plait, which turned out to be the *Poa pratensis*. Through the agency of the Society seeds of the grass were imported, and grown here.

William Cobbett thought he saw an opportunity of encouraging a useful industry in England, and printed an account of what had been done in his "Register." An importer of Italian straw then applied to Cobbett to know whether he could not get any of the American straw. The result of this was that Cobbett set to work in his usual energetic manner to see if English grasses might not be used for the same purpose, and he was successful in utilising various native straws and grasses. In appreciation of his efforts, the Society gave him a silver medal. Cobbett not being by any means a popular character at the time, the award did not meet with general approval. Edward Smith, Cobbett's biographer, says that the newspapers announced the award with the heading, "The Society of Arts humbugged at last." The award was of course perfectly well deserved, and apparently the real objection

* See a paper read by Robert Johnston to the Society. *Journal*, Vol. XX. (1871) p. 96.

† See the introduction (by E. F. Strange) to the catalogue of the collection of lithographs exhibited at the South Kensington Museum, 1898-99. This collection was organised and shown by the Science and Art Department, in response to an application from the Society of Arts, suggesting the commemoration of the centenary of Senefelder's invention by an exhibition of lithographs.

* *Transactions*, Vol. XI. (1793) p. 262; Vol. XII. (1794) p. xiii.; Vol. XIII. (1795) p. x.; Vol. XV. (1797) p. 131; Vol. XXIV. (1806) p. vii. In one place there is a mistake in the date, 1774 being printed for 1773.

† *Transactions*, Vol. XXIII. p. 223; Vol. XXVIII. p. 130.

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was to Cobbett's political views, not to the useful work he had promoted. However, the Society continued to encourage the industry, which it hoped might occupy numbers of unemployed, and for three or four years it continued to give a number of small rewards, varying in value from fifteen to two guineas for the manufacture of hats and bonnets made of English straw.*

The manufacture of leather received less encouragement from the Society than might have been expected, considering that the industry had one of its most important seats close to London, in Bermondsey. In the year after its formation (1755) a prize was offered for buff leather, then principally imported. The prize was duly awarded, and the manufacture started, with a certain amount of success. "The Kentish Militia and some other corps had their accoutrements made of it."† It does not, however, appear that the production of such leather was continued.

The story of the introduction of the method of "Dying leather red and yellow as practised in the East for that kind called Turkey Leather" is rather a curious one. Dossie‡ tells us that one Phillippo, "an Asiatic" who was in England, was induced by two members of the Society to "try, on his return to the East, to make himself master of this and some other arts not known here, in order to communicate them, by means of the Society, in case he should come again to England." The Society agreed to pay him £100 if he succeeded, and on his return to this country with the secrets of the process, the money was paid him, with the additional complimentary gift of a gold medal.

The tanning industry was a long established and flourishing one in this country, but it was hampered by protective legislation. Only certain materials, of which oak-bark was the principal, were allowed to be used. This provision was not apparently for the benefit of the tanners, but to secure the use of proper materials, and, perhaps, to encourage the growth of timber. As a matter of fact, not only was the bark of timber trees used, but oaks were grown in coppices, which were cut for the sake of the bark alone. The Act in which this provision was included was held to prevent the use of oak saw-dust, and therefore a method, said to be successful, of utilising this material could not be employed. The Society gave the inventor £100, and protested against the clause in the Act—with what effect is not recorded. Prizes were offered, and a few awarded, for new tanning materials and methods, but the list is not a long one.

A great many inventions for saving life from fire and for extinguishing fires were rewarded by the Society. Among the latter was an invention of Ambrose Godfrey for extinguishing fires, which was brought under the notice of the Society in 1760 by the inventor's son. To test the device, a building was erected in Marylebone Fields. On May 21st, 1761, the building was set on fire, and when it was in full blaze Godfrey's shells were thrown into the house. According to a contemporary description, "their explosion immediately extinguished the fire, and even the smoke soon disappeared." This demonstration was carried out in the presence of the Duke of York, Prince William, afterwards William IV., Prince Henry, afterwards Duke of Gloucester, and a numerous crowd which was kept in order by a guard of 200 men.

There were also a good many fire-escapes. One of these, for which fifty guineas were voted in 1810 to John Davis, is practically identical with the modern fire-escape with its telescopic ladder and carriage. In his description of his apparatus, the inventor says that his attention was drawn to the subject by the death of a woman at Chelmsford, who had fallen off a "parish ladder" when trying to escape from a burning house.

In 1805 a prize was offered for a method of rendering muslin uninflammable without injuring the quality or appearance of the fabric, but though the offer was continued for many years, it met with no response.

The proposal was a very old one. As early as 1735 a patent was granted to Obadiah Wilde, who added a mixture of alum, borax and vitriol to paper pulp, with the view of producing incombustible paper. In the early part of the nineteenth century the subject attracted the attention of many chemists, amongst others of Gay-Lussac, who in 1830 proposed the treatment of fabrics with the carbonates of potash and soda. Fuchs suggested water-glass. In 1859 an elaborate paper was read to the British Association by Versmann and Oppenheim, who gave a full account of their own researches. An abstract of this paper, and an account of the valuable investigations by Sir Frederick

* A very full account of the development of the straw-plait trade is to be found in a paper read by Mr. A. J. Tansley on December 19th, 1860, and printed in the *Journal* of the 21st of that month (Vol. IX. p. 69). In the discussion, the secretary (Mr. Peter Le Neve Foster) gave a very full list of the awards made by the Society from 1805 down to 1825.

† Dossie, Vol. I. p. 170.

‡ Vol. I. p. 230.

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Abel carried on from 1855 to 1881, will be found in a report of a committee of the Society on fire prevention, published in 1883.* This gives a fairly complete history of the various attempts to render fabrics and other materials uninflammable, down to the date of its issue.

The supply of fish to London had always been a difficulty, and though many attempts had been made to bring fish by land, none of them had succeeded.† In 1761 a scheme for the supply of the markets of London and Westminster—a new fish-market had been started in Broadway, Westminster, in 1752—with fish brought up from the coast by land was laid before the Society by John Blake. The Society took up the proposal very warmly, and agreed to give Blake £1,500 for the purpose of carrying it out. Eventually no less than £3,500 was spent on this scheme. The proposal was taken up with a great deal of enthusiasm. According to a statement in the first volume of the *Transactions*, Parliament also made Blake a grant of £2,000, and by the energy of the Society an Act of Parliament was obtained by which the tolls on fish carriages were reduced, and other facilities granted for breaking down the monopoly in the London fish supply which then existed.

At first the Society were very much gratified with the result of their efforts, and they awarded Blake a gold medal with the inscription, "Fish Monopoly Restrained." But the practical results of the procedure do not seem to have been very satisfactory, for in the article above mentioned,‡ it is stated that the "plan has not in every degree answered the sanguine expectations of the Society." Still, it is stated that a good deal of fish had been brought up by land, and the fish-supply of London increased. It also appears that the Society were not quite satisfied with Blake himself, because there is evidence in the minutes of disputes having arisen about his accounts.

A later attempt to develop British fisheries was more successful. In 1805 a reward was offered for "curing herrings by the Dutch method." For some years this does not seem to have had much result, but in 1819 and 1820 two rewards of fifty guineas and £50 respectively were paid to J. F. Denovan, of Leith, for his success in the "curing of British herrings," and for introducing them into the market. Two communications in the *Transactions** give an interesting account of the way in which, after many unsuccessful attempts to get hold of the secrets of the business in Holland, he secured the help of six experienced Dutch fish-curers, and with their help started to catch and cure herrings on the west coast of Scotland. After a good deal of trouble and various misadventures, he was quite successful in his enterprise, and succeeded in sending to Edinburgh and London cargoes of herrings equal to the best Dutch. The method employed, then as now, is merely, after gutting and cleaning the fish, to pack them in barrels with salt or brine. Many other awards followed, and this was the beginning of the Scotch cured herring trade, which developed into an important business, and has, of quite recent years, spread to the East Anglian fishing ports. At the present time it is a thriving industry at Lowestoft.

In 1783 the Society proposed to deal with the question of general education, and the following announcement was made in the first volume of the *Transactions*†:—"The Society, desirous to improve the present mode of education, hereby offer the gold medal to the master of any academy or school for boys situated within or not more than thirty miles distant from London, who shall within three years from the date of this advertisement teach the greatest number of scholars, not less than four, to write and to speak Latin in common conversation correctly and fluently. Also the gold medal for teaching in like manner each of the following languages, viz., the German, the Spanish, and the Italian, being commercial languages, not usually taught at schools in England."

In December, 1786, Dr. Egan, the master of the Royal Park Academy, Greenwich, brought up five of his pupils, whose ages were between eleven and fifteen, and they, after being duly examined by the committee, were each awarded a silver medal, the gold medal being given to Dr. Egan.

In its earlier years the Society offered various prizes of a miscellaneous sort, prizes which may be taken as evidence of the catholic nature of its objects from its very foundation. Such, for instance, was the gold medal for a treatise on the "Arts of Peace" offered in 1759, a time when the arts of peace must have been less in men's minds than those of war, since the country was engaged in fighting in Europe, Asia, and America.

* *Journal*, Vol. XXXII. (1883) p. 687.

† Some information about this will be found in "Industrial England in the Middle of the Eighteenth Century," p. 165.

‡ *Transactions*, Vol. I. p. 57.

* Vol. XXXVII. (1819) p. 183; Vol. XXXVIII. (1820) p. 186.

† Vol. I. (1783) p. 194.

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Among social and economical questions the question of female employment crops up again and again from 1768 onwards. Sometimes a reward is offered to those who employ the greatest number of women and girls in specified industries. Then more general offers are made—requests for suggestions, and so on. The general question of want of employment also comes up, and proposals are requested for providing employment for the poor, and for workhouse paupers especially.

It might be thought that the question of housing the agricultural labourer is a fairly modern one. It is certainly an object of discussion at the present moment. In 1799 the Society offered a gold medal to the landowner who should build in that year the greatest number of cottages with an allotment of two acres apiece, and another gold medal to the landlord who should apportion allotments of two acres to existing cottages on his estate. The offer does not appear to have attracted any response, and, after a few years, it was discontinued.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

Wednesday, January 24th, 1912; ROBERT KAYE GRAY, M.Inst.C.E., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Buchanan, James, J.P., Lavington Park, Petworth, Sussex.

Jones, Harry, 32, Acfold-road, Fulham, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Burns-Begg, Colonel Robert, The Residency, Salisbury, South Rhodesia, South Africa.

Cochrane, His Honour Judge Andrew January, Maysville, Kentucky, U.S.A.

Hart, William Edward, M.A., J.P., Kilderry, Londonderry, Ireland.

Heming, Arthur, 8, James-street North, Hamilton, Ontario, Canada.

McKerrow, George, M.D., 7, Barns-street, Ayr, Scotland.

Morgan, G. S. Delmar, B.A., Kuala Lumpur, Selangor, Federated Malay States, and Thatched House Club, St. James's-street, S.W.

Tubby, Alfred H., M.B., M.S., F.R.C.S., 68, Harley-street, W.

Veitch, Henry Newton, 22, Old Burlington-street, W.

The paper read was—

A NEW PROCESS FOR THE SEPARATION AND GRADING OF SOLIDS SUSPENDED IN LIQUIDS.

By WILLIAM J. GEE.

An important natural law, which governs a large number of industrial processes, is that which accounts for the property possessed by water and other liquids of holding in suspension particles or grains of insoluble solid matter, when stirred up with them, and afterwards depositing the solid material when agitation has ceased.

If we examine this phenomenon closely, we shall find that, where there are particles of different size or mass suspended in a liquid, these deposit in sequence, the heaviest or coarsest first, and the finest or lightest last. The time taken for the solid particles to settle out of the liquid may vary from seconds, in the case of sand or coarse grit, to days, or weeks, as in the case of very finely-divided material.

This phenomenon is illustrated in Fig. 1, which shows a section of a vessel where solid matter suspended in a liquid has been allowed to settle. *A* is the water from which the solid matter has been deposited, *B* and *C* indicate the fine and coarse particles respectively, ranging in successive strata, in the order of their settling, from the coarsest at the bottom to the finest at the top. It would not be impossible, although somewhat difficult, to scrape off successive layers from this deposit, and thus remove the deposited material in two or more classes or grades of fineness.

It is found also that solids are deposited from liquids which flow very slowly. In this case, the heaviest and coarsest settle first, as before stated, but the finer and lighter particles are carried further along before settling out. This is illustrated in Fig. 2, where a current of water is shown flowing through a long trough, entering at *A*, charged with solid matter, and, after flowing slowly along the trough, running off at *B*. By adjusting the rate at which the water flows, it would be possible to arrange that all the solid matter would be deposited in the trough, and the water would run off perfectly clear. If we examine the material deposited in the trough, we shall find that it is graded from one end to the other, ranging from the coarsest at *C* to the finest at *D*. This method has the very great advantage over that shown in Fig. 1, that the grades are deposited side by side instead of one

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on top of the other, and the removal of the material in the desired grades or classes is much facilitated.

It will, of course, be obvious that the movement of the water must, to some extent, retard the settlement of the solid particles, especially the lighter ones, and that, therefore, the deposition of the suspended matter from the water takes longer when the water is moving than it does when the water is quiescent. In practice, it is usual, in the many industries where this settling-out process is employed, to combine both methods. The water is allowed to flow along a slightly-inclined channel or series of channels, so as to settle out the coarser material, and then to run into a large tank or pit, where the finer particles are deposited by quiescent settling.

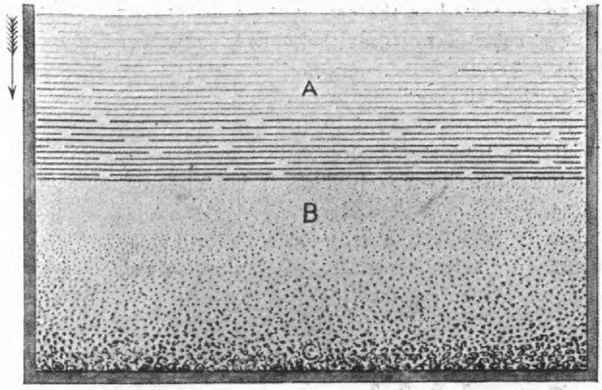

FIG. 1.

The slide now on the screen is a photograph of a "mica-drag," as it is called, taken at a China clay works in Cornwall. It is a typical illustration of the methods at present employed. Water containing in suspension the China clay is allowed to flow slowly along the parallel channels, wherein the fine sand and mica are deposited, and at the end of these channels it runs into the settling pits, seen in the distance, where the final settlement takes place.

It is not possible to get a perfect gradation by this method, as the channels are continually altering in level, because of the gradual silting up of the sand that takes place, the result being that the product from the settling-pit is usually found to contain some coarse material, and that the refuse in the channels has some fine clay with it.

The new process which I now have pleasure in bringing before you is a mechanical method of separating the solid matter from the water and, in the same operation, grading it. The process consists in passing the liquid containing the solid matter in suspension through a rapidly rotating drum, whereby the solids are caused by centrifugal force to be deposited on a removable lining on the inner surface of the drum, whilst the water or other liquid passes away clear of suspended matter. The essentially new and valuable feature of the apparatus is that a current of water is produced through the drum from end to end whilst the machine is rotating, with the result that the solids are deposited in the order of their mass, the largest and heaviest near the inlet end, and the finest and lightest near the outlet end, with every degree of fineness in between.

The apparatus is seen in sectional elevation in Fig. 3, and in cross-section in Fig. 4. The drum, *A*, fitted with a base, *B*, is mounted on a shaft or spindle, *C*, the whole being suspended from a ball-bearing of special design at *D*, supported between girders at *E*. Rotation is imparted by the pulley, *F*, to which a band-brake is fitted at *G*.

The upper end of the drum is closed by a cap, *H*, which makes a watertight joint with the drum at *I*, when clamped by the locking-ring, *J*. This forms a species of bayonet joint.

The cap, *H*, has a hole in the middle, and is held central on the spindle by means of the casting, *K*, which is a sliding fit on the spindle, and is connected with the cap by the upper ends of the six rods, *L*. At the bottom of the drum at *M* is fitted a weir-plate or diaphragm.

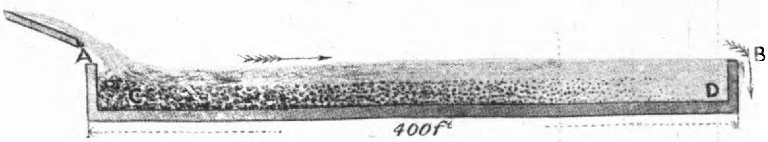

FIG. 2.

Depending from the cap into the drum is a kind of cage, seen best in the section, consisting of six vertical square rods, *LL*, to which are attached radial vanes or blades, *NN*. These blades extend the whole length of the drum,

being connected to the cap at the top end, and to a circular plate, *O*, at their lower end. The slide will make the "container," as it is called, quite clear to you.

The container slides easily in the drum, which it divides into six longitudinal compartments. Each compartment is provided with a curved plate, *P*. It will be understood that the container is, in effect, a removable lining to the drum, on which the recovered solids are received,

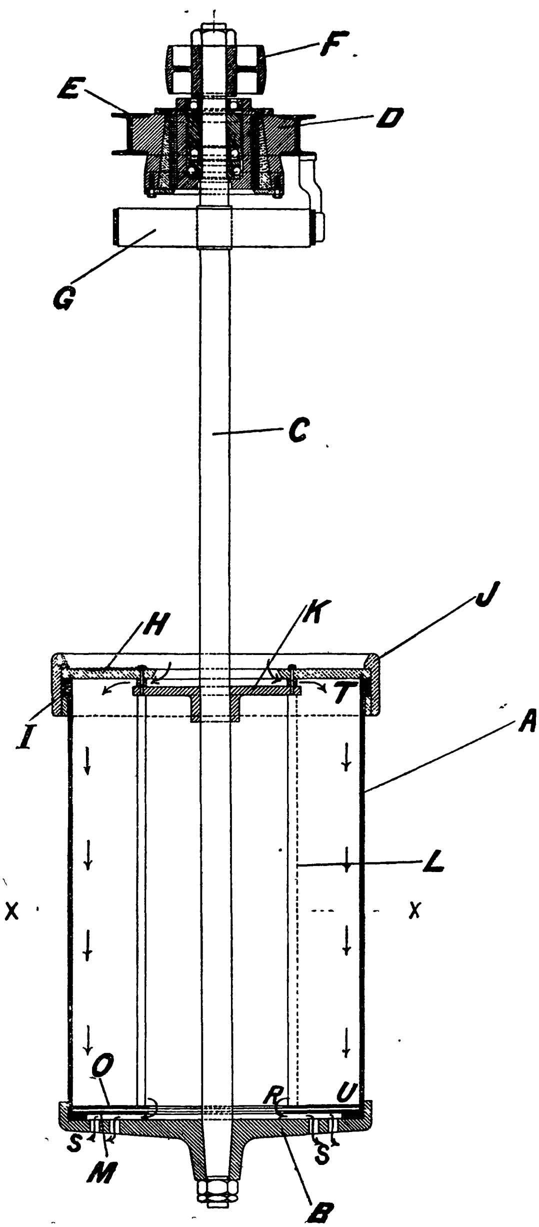

FIG. 3.

as shown in the horizontal section at *Q*. The operation of the machine is as follows:—

The requisite speed (usually between 100 and 200 ft. per second peripheral velocity) being

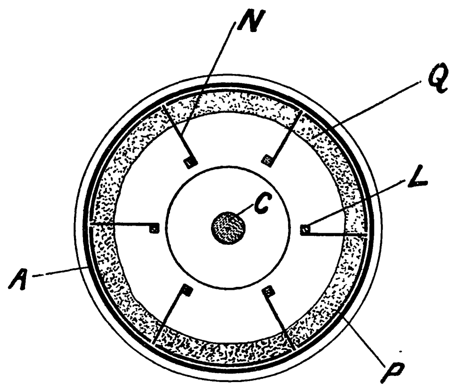

FIG. 4.

attained, the water containing in suspension the solid matter to be separated and graded is fed in a steady stream through the hole in the middle of the cap on to the casting, *K*, which also serves the purpose of a distributing-plate. The centrifugal force generated by the rapid rotation causes the water to fly to the wall of the drum and distribute itself thereon, so that an inner wall of water is soon formed which, when a given thickness is attained, overflows as indicated by the arrow at *R*, and passes out of the drum through the holes in the bottom, under the weir-plate, *M*, at *S*.

It will be understood that a slow, steady current of water is thus set up in the drum, in the direction of the arrows, and in passing down the drum, the solids in suspension are gradually deposited on the plates which line the drum. The coarse or heavy particles are very quickly separated, and these are found near the inlet at *T*. The finer particles are carried further along before they become separated, until the finest are deposited at *U*, near the outlet.

Consequently, the slab of recovered material ranges from the coarsest at one end to the finest at the other, with every possible degree of quality in between. The effluent water is quite clear.

When a sufficient charge of material has been recovered, the machine is stopped, the cap is unlocked, and the container drawn up by lifting gear (not shown) until the bottom plate, *O*, is within a few inches of the top end of the drum. The slides show views of the machine with the container in the raised position ready for

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discharging. The curved plates can readily be removed, with the slabs of recovered material adhering to them, fresh plates are inserted, the container is lowered into the drum and locked,

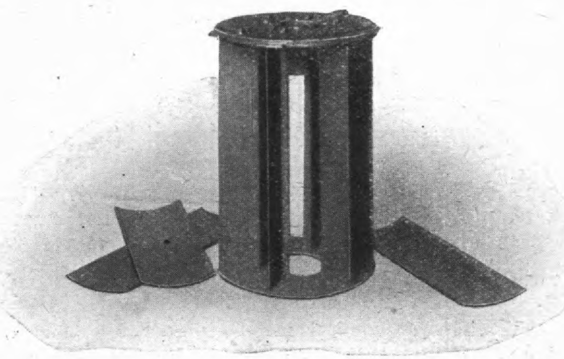

FIG. 5.—CONTAINER, SHOWING CURVED PLATES ON WHICH THE SEPARATED MATERIAL IS RECEIVED.

and the operation repeated. The slide shows a curved plate with the slab of material on it just as it is removed from the drum.

Four to five "journeys" per hour are made, and each operation in the usual-sized drum (3 ft. diameter by 4 ft. 6 ins. long) recovers about a quarter of a ton of graded material.

I have here a small machine which I propose to show you in operation. I must explain to you that it is necessary, in the commercial operation of these machines, that they should be provided with a reasonably firm foundation, or be built into the building in which they are worked; and as we have no arrangements of that kind here, this machine will have to run at a lower speed than would be used in the ordinary way. Luckily the grading effect can be exhibited perfectly at these low speeds, so from that—the most important—point of view, the demonstration will be perfectly illustrative of the results in commercial working. The only effect of the increased speed at which the machine works in actual practice is to increase the yield and to produce a dryer slab.

In order that the demonstration may be more graphic, I propose to mix together these two different coloured materials by stirring them together with water, and then to put the mixture through the separator, when we will find that they are separated from one another again. At the close of the meeting I hope you will be good enough to come and inspect these slabs more closely, when you will be able to see the grading effect produced by the apparatus much more clearly than at a distance

The industrial applications of the process are very numerous. A large number of commodities, such as whiting, fuller's earth, China clay and other clays, ochres, umbers, and other earthy pigments, Tripoli powder, pumice powder, emery and other polishing substances, and so on, are at present treated by first grinding or puddling them with water, and afterwards settling them out of the water in the various grades, in the manner I have already indicated. All these commodities can be treated by my process with results which are entirely satisfactory.

It would take too long, and would involve much repetition, if I were to deal separately and in detail with the application of the process to each of the commodities I have named, so I propose to select one of them, which is fairly representative of the remainder for detailed description. You will understand that, in reference to all the industries I mentioned, the process is equally beneficial.

We will therefore consider the application of the process to the production of China clay, or kaolin. This commodity is produced in Cornwall, and, to a smaller extent, on the edge of Dartmoor, in Devon. The present production

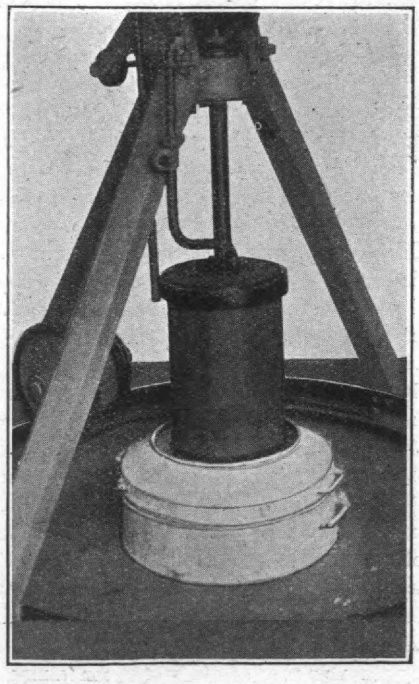

FIG. 6.—MACHINE READY FOR RUNNING.

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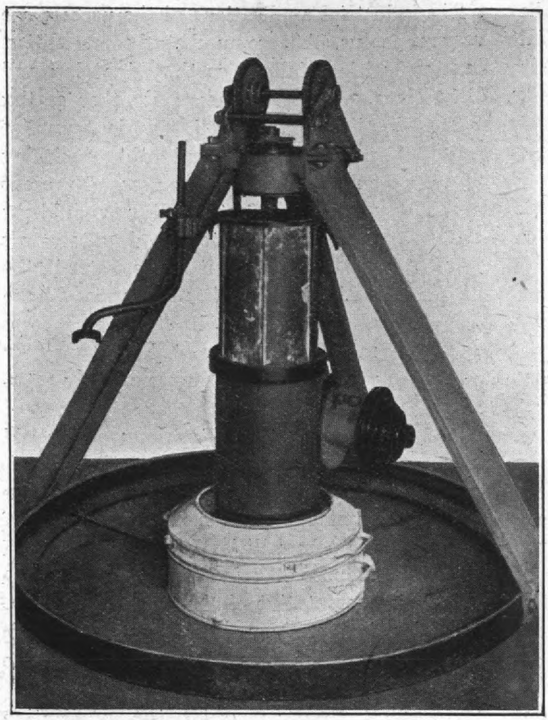

FIG. 7.—MACHINE WITH CONTAINER IN RAISED POSITION.

is about 800,000 tons per annum, and is rapidly increasing. Most people, excepting, of course, those who are directly connected with the industry, are under the impression that the chief use of China clay is in the manufacture of pottery. This is not the fact. By far the largest demand for China clay comes from the manufacturers of paper and textile goods, who use it in the sizing and dressing of their products.

As found in the earth, the raw clay is mixed with boulders, small cubes of quartz, fine sand, and mica. It is washed out of its bed by a species of hydraulic mining, in large open workings, often several acres in extent. The boulders and coarse quartz gravel are left behind in the pit, to be dug out and dumped separately, and the water, carrying in suspension the clay, and with it the fine sand and mica, is pumped up to the top of the pit. After passing along the channels, or "mica-drags," it is settled out in settling-pits, whence, after standing for two to three weeks, so as to get as firm a sediment as possible, the water is run off, and the clay is ladled out in the form of thick sludge, and dried in kilns, called locally "drys."

By the new process the water containing the clay in suspension will be fed into the machines, where the clay will be separated from the water, to put it graphically, in as many minutes as it now takes days. The clay is removed from the drums in a more or less solid state, which, compared with the semi-liquid sludge of the present method, admits of considerable economy in the cost of drying. By the present method, for every ton of clay dried, not less than one ton of water has to be evaporated. The economy in drying cost is not only due to there being less water to evaporate, but is further increased by reason of the new method admitting of the employment of modern air-tunnel dryers, in which warm air circulates round the cakes. This is probably the most economical method of drying. It is considered so in the brick and tile industry, where it is in general use. Although warm air drying is so superior to kiln drying, it is not practicable with the semi-liquid sludge which has to be dealt with now in Cornwall. It is not an unimportant point that, in drying by warm air, all risk of burning the clay is avoided. It is therefore claimed that, directly and indirectly, the use of the new process will effect economies to the extent of at least 4*s*. per ton in the cost

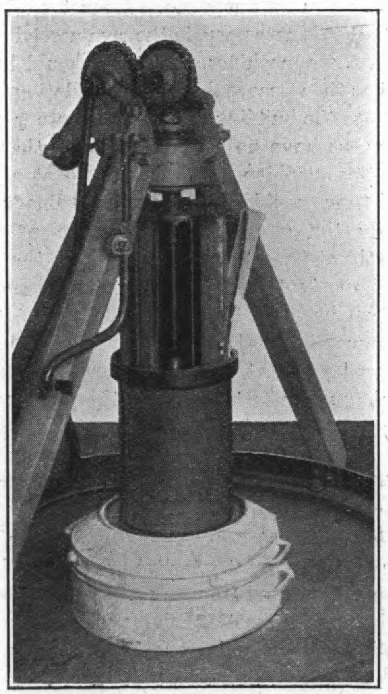

FIG. 8.—MACHINE SHOWING HOW SLABS ARE REMOVED.

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of producing the clay, which cost now averages about 10*s.* per ton, or, in other words, a saving of 40 per cent.

But this is not the principal advantage of the process. The standardisation of quality, which the grading effect of the process provides, is even more valuable. It is easy to arrange that the machines shall all rotate at the same speed, and be fed through the same sized pipe, and therefore the slabs of recovered material must always be alike. As, by means of a gauge, the different qualities can be exactly separated, it follows that absolute standardisation of quality can be relied on. The highly-refined, superfine clay from the fine end of the drum is a quality

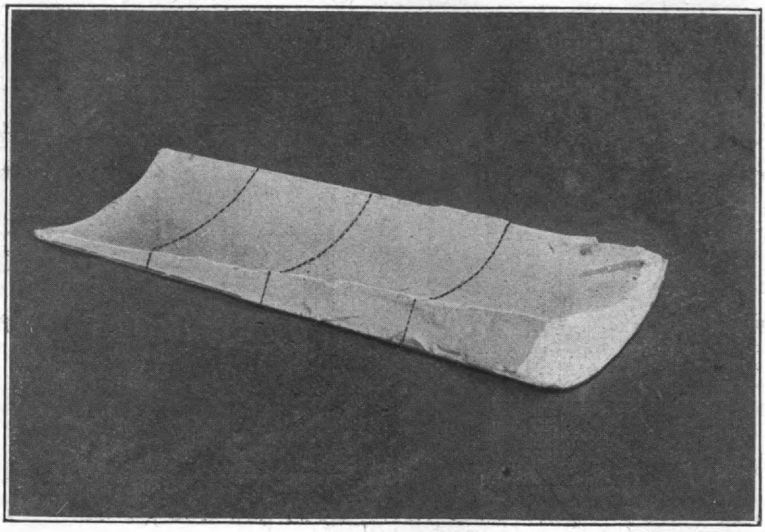

FIG. 9.—SLAB OF RECOVERED MATERIAL, SHOWING HOW THE GRADES ARE CUT.

absolutely unknown on the market at present, which will command very high prices. An average sample of China clay, as now produced, was re-treated by this process, and the graded clay thus obtained was submitted to commercial valuation. The report received showed an average increase in value of 6*s.* per ton. If we now add together the 4*s.* saved in cost of production and the 6*s.* increase of value, owing to superiority of quality, we get an advantage of 10*s.* per ton to the producer over and above his present profits. This should lead to some interesting developments in the China clay industry, as the finished clay now goes aboard ship at an average price of something less than £1 per ton.

This necessarily brief sketch of the application of the process to a representative industry will serve to give an idea of its value in relation to all other allied commodities which are now produced by levigation or elutriation in water. The advantages obtained may be summed up under two heads:—

1. Saving in cost of production by reason of greater efficiency of plant, lower labour cost, and lower capital cost.

2. Increased value of product, because of exact and reliable standardisation of quality.

The machine you have seen is also applicable to the separation of solid matter from liquid where grading is of no importance, but the object is mainly to get the suspended matter out of the water as quickly and cheaply as possible. The machine is very efficient, considered from this point of view only, much more so than the method frequently adopted of filtering through cloths, etc. In this connection, I have recovered waste fibre from the effluent water of paper mills, clarified the effluent from collieries, etc. I am now investigating the application of the machines to the treatment of sewage or sewage sludge.

Mentioning collieries reminds me of a very interesting experiment I made recently. A sample of coal was sent to me, containing about 16 per cent. of silicious ash. The object sought after was the removal of the silica from the coal. I had the coal crushed to fine powder, and was able to get a very satisfactory result. This will probably be of great importance, as there are, I understand, in some of the colliery

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districts, millions of tons of dumps, consisting of waste coal, which would be very suitable for coking purposes or briquetting, if only the silica could be got out of it. I have no doubt, from what I have done, that we shall be able to convert this waste material into a valuable commodity.

I would now like to deal with a mechanical problem which had to be solved during the early work on this process. When a body such as the drum of this machine, which is longer than it is wide, is set rotating at a high speed, a precessional movement is set up. In other words, the axis of the machine wants to rotate around the centre line, just as the boy's peg-top, when it begins to spin, "wobbles" for a while, and then "goes to sleep," as we used to say when we were schoolboys. Now, if we hold the machine rigidly in bearings at each end of the spindle, this precession at high speeds becomes converted into a constant vibration, to overcome which a very heavy framework and substantial foundations are necessary.

It is usual, therefore, in all centrifugal machines, to suspend them from one bearing at the top, and hold the housing of this bearing in rubber washers. This is done so that the machine may, within limits, "wobble" as much as it wants to, and finally "go to sleep." The usual kind of bearing was, however, insufficient for this type of machine, with a drum whose longitudinal axis is greater than the diameter, and it was only after much trouble and experiment that the bearing shown in Fig. 10 was evolved.

In this figure, *A* is the spindle of the machine, which is fitted with two radial ball-bearings, *B*, separated by a distance piece, *C*. The weight of the machine is taken by the thrust ball-bearing, *D*, through the thrust collar, *E*. These ball-bearings are enclosed in the housing, *F*, which is furnished with an outward flange at the top, which prevents the housing from slipping through the rubber washer, *G*. This is a cylindrical tube of rubber completely embracing the ball-bearing housing, and is in its turn enclosed in a collapsible steel cone, *H*. This steel cone is made collapsible by means of a number of saw cuts in alternate directions. It fits a corresponding cone in the casting, *I*, and by means of the nut, J, the collapsible cone may be screwed up and so made to compress the rubber cylinder to any desired extent. This adjusts the control which the rubber exerts on the precessional oscillations of the drum. The plate, *K*, at the bottom prevents the rubber cylinder from being drawn through the cone.

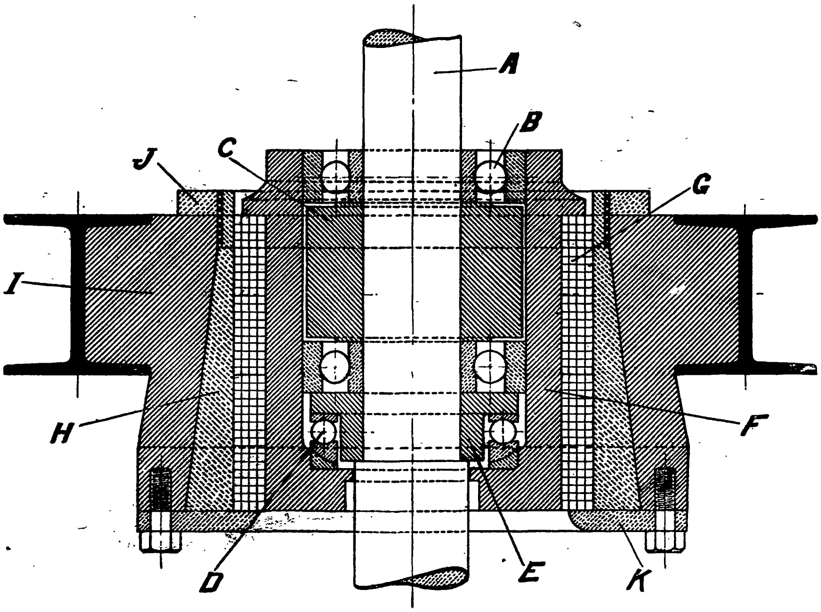

FIG. 10.

The effect of this specially-devised bearing is that the drum, after a few oscillations at starting, runs perfectly quietly and smoothly, and, as it runs on ball-bearings, the power required to maintain it at speed is very small. As to lubrication, the bearing only needs to be filled with

lubricating grease every two or three months to keep it in perfect order.

I am glad to say that the apparatus is very unlikely to get out of order. There is only the one bearing, which, as you have seen, does not require frequent attention, and there are no complicated or difficult parts anywhere else. The operation of the drum, too, is simple. All the attendant has to do is to arrange that the water containing the suspended matter is fed in at such a rate that the effluent is just clear. That indicates that the machine is working at its greatest efficiency at the particular speed at which it is running. If, by accident or carelessness, the attendant feeds too slowly, the result will be that the slab of recovered material will not be properly spread over the whole length of the drum, but will be too thick at the coarse end, with very little, or nothing, at the fine end. If, on the other hand, he feeds too quickly, he will lose some of the fine stuff with the effluent water, because the material will not be long enough in the drum to separate all of it. These faults will be immediately recognisable when the drum is discharged, and the remedy will be at once apparent. If, again, he forgets to lock the cap, he will get a shower-bath to remind him of his omission, but in no case will the machine be likely to be put out of order by any carelessness or stupidity on the part of the attendant. Naturally, the rapidly-rotating drum must be fitted with guards, in the same way as all high-speed machines are protected. In most cases it will be found the most convenient method to run the machine in a pit, with the top of the cap level with the floor, or, if not, a floor for the workmen will be erected at that level, which is the most convenient for access to the container in the raised position when the slabs are withdrawn.

I have not the time, nor is this the occasion, to go into the more or less abstruse mathematics of the process, but I want to mention one problem to which I would like a solution; and I bring it before you in the hope that someone present can evolve for me the required formula. You will know that, in dealing with compressed air, we speak of the compression being equal to so many "atmospheres," that is to say, so many times the normal pressure of the air. Now, I want a formula for calculating the separating efficiency of these machines in "gravities." I have, of course, been able to arrive at a working solution by the simple method of taking the time of quiescent settlement, and comparing it with timed results with the machine, but I feel sure that a simple formula should be available, although I have not hit on it.

I hope I have now succeeded in giving you a good general idea of the separating and grading process, and its varied application to industrial purposes, and I now propose to deal with a new departure which I have made in the direction of applying the process to ore separation. I may mention that, from the earliest time, I have had it in mind to investigate the possibility of treating ores by centrifugal methods, and I had no chance of forgetting it, because nearly everybody who saw the process in operation said, "Why don't you treat ores by it?" I took an early opportunity of putting some water-suspended ore through, but I found it was only a qualified success, because the machine separates not only as to the specific gravity of the particles, but also as to the size of them. Consequently, when crushed ore was suspended in water and passed through the drum, the metallic particles came out at the top end of the drum, but so also did the coarser particles of the gangue, and similarly at the fine end there were usually some extremely finely-divided particles of metallic mineral, especially when tin ores were being treated.

I therefore waited until the process I have already shown you was perfected, and the machines being made commercially. Then I felt at liberty to devote myself particularly to the study of ore treatment, where the object sought is separation entirely as to the specific gravity of the particles without any reference to the size of them. I took an opportunity of observing the usual concentrating tables, vanning machines, buddles, etc., at work on various mines in Cornwall last summer, and I finally summarised the principles employed in existing mechanical concentrating plant into one governing proposition, viz., that the crushed ore, being suspended in water, is submitted to two forces acting at a right-angle to each other: (1) the force of gravity, causing the metallic particles, by reason of their greater inertia, to tend to remain behind; and (2) the flow of the water, which carries away the lighter or gangue particles.

In the end I evolved a separator of a new type, which carries out these two essentials. This is illustrated in Fig. 11 in sectional elevation, and in cross-section in Fig. 12. In this machine we have the drum, *A*, mounted on the base, *B*, and closed at the top by the cap, *C*. Ball-bearings, *DD*, at the top and the bottom of the

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drum are placed so that the drum may rotate on, but independently of, the shaft or spindle, *E*. I should mention here that, as this ore machine runs at a lower speed than the grading-machine, there is no objection to putting bearings at both ends of the drum. The weir-plate at the bottom, inside the drum at *F*,

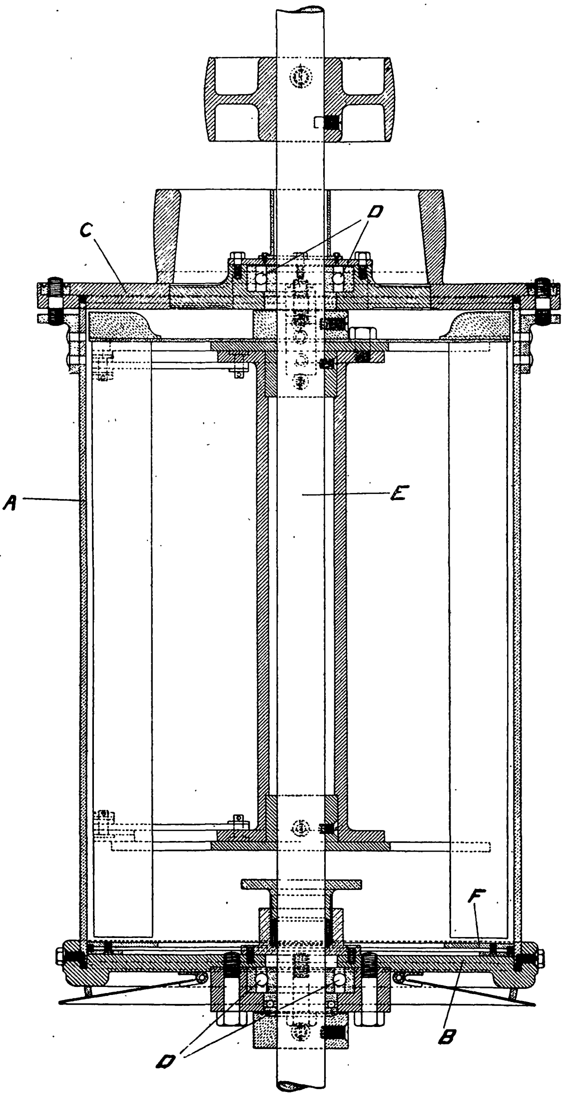

FIG. 11.

serves the same purpose as in the machine you have seen—namely, to provide an inner wall of water of the desired thickness within the drum. The shaft, *E*, is fitted with bearings at each end, and attached to the shaft, within the drum, but clear of it, are a number of radial vanes or blades, extending the whole length of the drum, and so arranged that the distance for which they dip into the wall of water may be varied, so that the grip of these blades on the water may be adjusted.

The principle of the apparatus is that the drum is caused to rotate at a given speed, and the wall of water is caused by the vanes to rotate within the drum at a greater speed, but in the same direction. These speeds, and their ratio to one another, may be adjusted within very wide limits. The result is that the particles of greater specific gravity—for instance, tin oxide, with a specific gravity of 6·7—are, by reason of their greater inertia, caused to deposit on the drum and remain there, whilst the particles of lesser specific gravity—let us say quartz, with a specific gravity of 2·65—are carried along with the water and discharged with the effluent. You will have understood, from what you have already seen, that centrifugal force acts, in these centrifugal machines, in precisely the same way as gravity does on a concentrating table. The only difference, so far as the effect is concerned, is in the intensity which, in this machine, is about a hundred times as great as on the concentrating table. It is easy to adjust the speed at which the water travels relatively to the drum, so as to effect practically a perfect result.

The method of operating the separator is as follows:—The drum and the vanes are set rotating at the required speeds, and clean water is fed into the drum until an effluent is observed at the outlet. This indicates that the wall of water in the drum has been obtained. The inflow is now changed to water-suspended ore, whereupon the separation of the metallic particles is effected, as I have just described, during the passage of the material through the drum, and the effluent will consist of water-suspended gangue only. The inflow of ore is continued until a sufficient deposit of concentrates is obtained, and it becomes necessary to discharge the metallic material. The discharge is effected in the following manner:—The inflow is changed over from ore-water to clean water, and in a short time all the gangue still in the drum will have been carried away and the effluent will be clear. There will now be in the drum only a wall of clean water, with a thin layer of concentrates adhering to the inner surface of the drum. The effluent is now changed over to the waste, and put into communication with the reservoir for concentrates. The drum is then retarded or stopped whilst the vanes still rotate. The stirring action of the vanes is thereby increased to such an extent that the concentrates are washed off

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the drum, and the continued inflow of clean water carries them away to the reservoir. In a few seconds the drum is quite clean. The effluent is now reconnected to the waste, the speed of the drum is restored to its proper ratio, the inflow of ore-water recommenced, and the cycle of operations repeated. Gearing will be provided whereby these operations are periodically performed mechanically, and the apparatus rendered wholly automatic.

It will be understood that the apparatus must be carefully adjusted by a skilled metallurgist to the material to be treated when it is first set up. He will have a rough guide furnished him, but he will have to make experimental runs, and test the results by analysis or assay. There are five different factors in adjusting the apparatus, viz. :—

1. The speed of the drum.
2. The speed of the water.
3. The grip of the vanes on the water, varied by moving them towards or away from the drum.
4. The thickness of the wall of water.
5. The rate of flow through the drum, which varies the time during which the material is being acted upon.

This preliminary adjustment, although it sounds rather formidable, is really not very difficult, but it is worth while to spend some time on it, because once the apparatus is adjusted to the particular material to be treated, no further skilled attention is required. In fact, the only labour of any kind that will be required will be for the purpose of keeping the plant supplied with material on which to work, and every month or so filling the ball-bearings with lubricant.

The ore must be crushed or ground sufficiently fine to ensure that the particles of metallic material are separated from the gangue particles. It will be obvious that if we have a particle of material which consists of a mixture of the metal and the gangue, then the specific gravity of that particle as a whole will be somewhere between the specific gravity of the gangue and the metal respectively. It is this factor that accounts for the relatively poor extraction of tin by Cornish mining methods. The tin oxide, or some of it, exists in such a finely divided state that extremely fine crushing is necessary before the metal particles are separate from the gangue particles, and, until that condition is arrived at, the difference in specific gravity between the particles, which is all we have to rely on for effecting a concentration, does not exist, or, at best, exists only partially.

There is no difficulty in grinding the rock finely enough at a reasonably low figure, but the trouble hitherto has been that the present mechanical concentrating methods are not suitable for the concentration of finely crushed ore; in fact, it is usual at present to regard crushers as efficient or the reverse, according to the amount of "slimes" they produce. As slimes are at present a bugbear to the ore-dresser, he wants to avoid making them as much as he can.

I am glad to be able to tell you that I have treated slimes in my ore separator, and I find that they can be concentrated perfectly; in fact, since, as I have shown you, fine crushing is essential to a rich concentrate and a high percentage of extraction, I prefer that the ore be crushed as fine as possible—the finer the better.

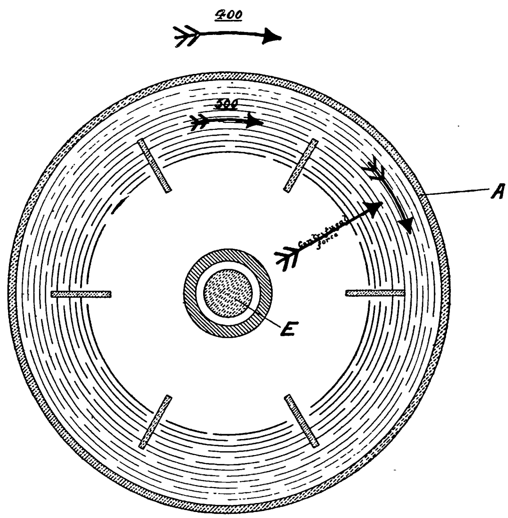

FIG. 12.

I am told that the hardest rock can be reduced to fine powder or slime for under 1*s*. per ton by a new method of dry-grinding that is now available. It is a matter of common knowledge in Cornwall that tens of thousands of pounds' worth of tin is running away down the rivers into the sea every year because it is too fine to be recovered by present methods. I expect to be able to put an end to that state of things.

Although the ore separator is a quite recent development, and I have therefore not yet had time to examine and work out all the various ramifications of the process, I have been able to make a series of practical tests. From what I have already done I feel justified in claiming that this process will do everything that the present mechanical concentrators will do, but

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in a much more economical and efficient manner. I expect to get a 95 or 97 per cent. recovery of the metallic content of an ore. In addition, the process will treat to great advantage ores which have up till now defied mechanical treatment. It was found impossible to arrange in time to have an ore separator at work here to-night, but I have here some samples of treated and untreated ore, and I hope that you will come and examine them at the close of the meeting.

It may seem to you that the claims I have made for the process are too optimistic, but I can only say that they are based on practical results. The simple explanation is, that whereas the usual concentrating tables and vanning machines use only the force of gravity, the Gee concentrator employs centrifugal force, which, although otherwise precisely the same in effect, may be varied at will, as regards its intensity, by varying the speed of the drum. The precision with which the process may be adjusted is sufficient explanation of its seemingly marvellous efficiency as regards percentage of recovery and richness of concentration, and the magnification of gravity (for this is what it really amounts to) which is brought about by the use of centrifugal force is the measure of the increased output, as compared with ordinary methods of mechanical treatment. The separator will run at a power cost of considerably less than one penny per machine per hour, and each machine will treat at least two tons of ore per hour.

I am now pushing on as rapidly as possible with a large separator, embodying all the minor developments which suggested themselves during the work with the first apparatus, and I expect to be able in the near future to collect authoritative data as to the performances of the process in commercial work on various kinds of ore.

In conclusion, I express the hope that at a later date I shall again have the privilege of addressing you here, and giving you more definite and established information about the ore concentration process than at this early period it is possible for me to give you.

DISCUSSION.

DR. E. FEILMANN, in opening the discussion, thought the method of calculating the force exerted on each particle in terms of the ordinary action of gravitation as a unit was fairly simple. The centrifugal force on a particle revolving with a peripheral velocity of v at a distance of r from the axis of revolution would be $\frac{v^2}{r}$, according to a well-known formula. Calculating on that basis, for a drum of three feet internal diameter, with a velocity of revolution at the periphery of 200 feet per second, it would be found that the action at the surface was 850 times that which was due to gravitation, which apparently showed a very considerable advantage in that direction. There was another feature of the process, looked at from a mechanical point of view, which might be of importance. If instead of taking the peripheral velocity and the radius of the drum, the formula was expressed in terms of angular velocity, varying the radius, the formula was obtained of $4n^2\pi^2r$, for the centrifugal force, where n was the number of revolutions per second. The important point of that was that the action exerted on each particle varied directly as the distance from the centre of revolution, and there was, therefore, a constantly increasing force acting on each particle as it traversed the layer of liquid from the inside layer to the outside of the drum. This was a different effect from that obtained with an ordinary concentration table, where the force of gravitation acting on the particle was the same throughout. He had not gone into the question of exactly how that affected the grading, but although he would not like to dogmatise about it, it looked as if it might help the process at that point.

MR. A. CAVIN HODGE, after congratulating the author on the very beautiful photographs he had shown of the clay pits at St. Austell, of which place he was a native, said that if Mr. Gee's invention was as good as he had given his audience to understand it was, he was sure the whole of the clay district of Cornwall would be only too pleased to adopt the process. The author had not stated whether the machine was to operate in the pit, or whether the water was to be pumped, as it was at present, to the surface, and subsequently to go through the machines. If the latter was the case, he thought the machine would have very little duty to do. That was a question which from a commercial point of view particularly interested St. Austell men. Another practical point was that a certain amount of iron existed in some of the clay works, and it was well known that a small percentage of iron was detrimental to the concentration of the clay. Would Mr. Gee's machine assist in freeing the iron from the clay, or would it still remain in the clay?

MR. RENOLD MARX said the author had stated that his apparatus was peculiarly fitted for the recovery of fibres from the backwater of paper-mills, and it would be interesting to hear whether any figures were available as to the performance of the apparatus on that class of work. The principal method in use at present in paper-mills was that of decantation. The apparatus embodying that principle was an extremely simple one, and the results obtained by the author's apparatus would have to be very good indeed to be of practical commercial value to paper-makers.

MR. W. H. PATCHELL asked the author whether the 800,000 tons of clay, which he said in his paper

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were produced per annum, related only to clay, or included China-stone, and mica-clay. If, as the author stated, those 800,000 tons were worth £1 a ton, and the machine increased the value by 6*s.* a ton, it represented a gain of £240,000. From a commercial point of view it would be interesting to know whether, if clay went up in price from 20*s.* to 26*s.* a ton, there would be a market for it. Would people who now paid 20*s.* fall over each other to pay 26*s.*, or would there be a smaller demand for the 26*s.* clay? The author had not stated what percentage of water was contained in the clay as it left the machine. From the sample the author had shown it looked pretty much the same sort of clay that was generally put on a pan, and that contained at least 50 per cent. of water. If the machine was run longer with a solid back similar to that now used, he was not sure that the clay would be obtained very much drier. With a perforated back a certain amount of clay would be lost, but the clay that stuck to the back would act as a filter, and a very much drier residue would be obtained than when working with a solid back. The author had further stated that ore could be ground for a shilling a ton. It would be interesting to have further particulars of the cost of the grinding, and the cost of the power used. Did the penny an hour, at which the author said the machine could be run, represent a pennyworth of coal or of electricity; and if the latter, what was the price per unit? With regard to the question of settling, the particular water used made all the difference in the rate at which the material would settle in the water. When Archbutt and Dealy started water-purifying, they found that if yesterday's dirt was stirred up from the bottom of the tank, the next day's lime crystals settled very much more rapidly than if the tank was absolutely clean and the day's dirt was settled by itself. People working that process always left a certain amount of dirt in the tank, the usual practice being to blow it up with an air jet, so that a thorough mixture was obtained of so much of yesterday's dirt with its larger crystals, and the next day's dirt with its finer crystals. If a start was made with clear water and no yesterday's dirt, and a little alum was put into the dirt, it brought the clay down very quickly. Aitchison, who had been working very much on those lines, and who had dealt with the question of flocculation, had found that if straw was put into the water it very much increased the rate of precipitation. In reply to the previous speaker, who asked if the machine would bring out the iron, he thought it would not, because iron was not brought out by ordinary gravity. The author's machine did not act on any other principle than ordinary gravity, except that it hustled it up a bit.

Mr. W. N. Gardner inquired whether the author had tried any other liquid but water—for instance, oil—in the separation of ores. He thought that, if the ores were first passed over oil, some very interesting results would be obtained.

Mr. Walter F. Reid said that, judging from what he knew of the China clay industry, and from the author's statements in regard to it, it would prove rather costly to work with a machine similar to that shown. It would be interesting to know what the cost of labour was for clearing out the clay per ton. It also seemed to him that if the value of the finer portion of the China clay was increased, the quality of the coarser portion would be deteriorated almost to the same extent. Were the audience to understand that the whole of the material was increased in value or only a portion of it? In his opinion the process could be adapted more or less to materials of the same kind rather than to materials of a different kind. It was evidently a splendid grading machine. If emery or any material that would stand the action of water was ground to different degrees of fineness, it seemed to him the principle would work very well indeed. He was inclined to doubt the figure given for the cost of power, and would like to know how it had been arrived at. It would also be interesting to know whether the machine would separate, for instance, particles of clay and chalk. In the cement industry there was an enormous field for separating the "slurry" quickly, and if it could be utilised cheaply in the industry that was an application of the author's invention at least as big as its application to China clay.

Mr. W. S. Lockhart, in dealing with the question of different specific gravities, thought it would be as well to add in the third paragraph of the paper that the separation being effected in the long channel was effected on material of the same specific gravity. He thought that that was what was intended, and it would be as well to say that the question of the specific gravity did not come in there. It was only intended if materials like China clay or mica were used. In the final paragraphs of the paper another correction was required, where he thought the author meant to convey that the value of the process was dependent upon the smallness of the amount of slimes produced, and not upon the amount of slimes produced. It would be interesting to know what percentage of speed would be allowable to make any very serious difference in the results obtained from the machine. Centrifugal machines had previously been used for ore-dressing, and the great trouble experienced had been to get even turning from the beginning to the end of the day. Even very small differences in the speed of the engine would make a considerable difference. Several machines based on centrifugal force had failed for that reason, and he would like to know to what extent this would affect the author's machine. It was interesting to hear that, by application of centrifugal force, very finely divided ground ore could be treated, because those

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who were accustomed to ore-dressing knew that after a certain point fine materials did not behave well in ordinary water, the water not being liquid enough. If the ore could be dressed with oil or turpentine, much better results would sometimes be obtained, but if centrifugal force would do the same work with ordinary water it would be a very great advantage to the mining industry.

MR. A. L. JOHNSON inquired whether the author used any special type of motor to drive the machine, and the kind of current used.

THE CHAIRMAN, in concluding the discussion, said that one great advantage of the author's machine was its simplicity, and from the test which had been carried out in the presence of the audience the difficulty of the precessional movement, so far as he was able to judge, had been overcome. The reason that the residue was rather moist, a point to which Mr. Patchell had referred, was probably due to the fact that the machine was not driven at the proper speed. Ever since the time of Adam people had been endeavouring to evolve a process for the separation and grading of solids suspended in liquids, and it was therefore extremely difficult to produce anything new on the subject. The market was full of machines of different sorts, and if Mr. Gee had discovered a way of successfully dealing with the problem he was heartily to be congratulated, but it was only possible to judge of the success by the results obtained. Still he thought that what the author had shown had, to a certain extent, solved the problem.

MR. W. J. GEE, in reply, said he was exceedingly obliged to Dr. Feilmann for the formula he had given, the result of which, 850 gravities at that speed, was, he thought, theoretically correct. Observed by timed results, the effect was, at the speed he (the author) gave, as nearly as he could say about 475 times the force of gravity. In order to get a real result it was necessary to take the mean thickness of the wall of water, and from observed results it was very difficult to say whether the time of settling in a vessel had been quite correctly observed. With regard to the question of placing the machine in the pit, obviously his process was a substitute for settling-pits, the claim being that the machine effected practically instantaneously what occupied a long time in settling-pits. With regard to the question of the improvement in the value of the clay, all kinds of samples of clay had been sent to him from Cornwall, and he had always been able to produce at the fine end of the slab some exceptionally fine clay, finer than the finest clay he had ever seen. His method of separation and grading was practically mathematically accurate, a result so accurate being obtained that it was possible to produce a standard quality. He had dealt with the question in the paper from a scientific point of view, and he was not present at the meeting to advertise the process, but he would be very glad to supply further details if communications were sent to him. With regard to the question of the percentage of iron, he had received chemical analyses from one of the leading authorities on clay, taken from various portions of the drum, which showed that there was considerable diminution of the quantity of iron as between the coarse end and the fine end of the drum. Iron was present in the clay in two or three different forms, and it was very difficult to say whether the iron was got out by reason of the fact that it had a greater specific gravity, or on account of the size of the particle, or whether it might be true that some of it was combined with the coarse particles. From the point of view of the analytical result there was a considerable improvement, not only in the fineness of the particle at the fine end of the drum, but also in regard to the iron contents. He had had the opportunity of running the effluent from paper-mills through his machine, with the result that the paper fibres and other suspended matter came out quite readily; in fact, there was very little difficulty in getting almost any suspended matter out of water by passing it through the drum. The question whether it would pay could only be settled by actual experiment. A machine three feet in diameter and four feet six inches high could be seen running in London at a cost of well under one penny per hour. It was safe to say that in almost any part of the country five horse-power could be obtained for a penny an hour, seven horse-power being nearer the average. His machine took between three and four horse-power when running at full speed, but to start with there was an overload of about six times the normal load factor for the purpose of getting up full speed. The question of keeping the speed regular naturally appealed to anyone who was interested in the subject of ore treatment, because speed was most important in dealing with the concentration of ore. Even if the speed did drop, however, the ratio remained the same. He had a machine running at his laboratory driven by an ordinary electro-motor with a controller attached to it, so that by moving the arm of the controller he could obtain any speed desired on the drum for experimental purposes; and it seemed to him it would be easy to put a governor on the machine which would move the arm to and fro and give the exact speed required. If he found in the course of his operations that it would be necessary to provide some means by which the speed must not be allowed to go above or below a certain limit it could easily be obtained. In the ore machine he described, it was intended that the iron should be separated by specific gravity; and it did so very nearly indeed, although he had not actually demonstrated yet the limits as to the size of particle. With regard to the question of the cost of grinding, he had been informed that there was a new grinding apparatus available which would enable the hardest rock to be ground for under ninepence

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a ton, and in order to be on the safe side he had put down the figure of a shilling. With regard to the cost of labour for handling the China clay, two men would be able to look after four or probably five machines, each producing one ton an hour, so that if sixpence a ton was allowed for labour it was well above the mark. The process, so far as it related to China clay, had to be considered from two points of view—the cost of labour and the quantity of material extracted from the water—but when such a material as sewage, or a material in which there was only a small quantity of solid matter in the water was being dealt with, it was necessary to pay regard to the efficiency of the machine. The quantity of water clarified in a given time would have to be worked out. The figure of 800,000 tons, the estimated production of China clay for 1910, was derived from the Home Office Report of the Inspector of Mines and Quarries.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Gee for his interesting and instructive paper, and the meeting terminated.

THE RECRUITING OF THE EMPLOYING CLASSES FROM THE RANKS OF THE OPERATIVES IN THE COTTON INDUSTRY.*

This paper records the results of an interesting investigation made by circular and by direct inquiry. Returns received from a number of manufacturers showed that some 80 per cent. of those willing to give information had begun life as operatives or clerks. A direct investigation was then made in a well-known manufacturing town, and it transpired that some 60 per cent. of the heads of private manufacturing businesses owed their position to their own efforts and that they had begun life in the lower economic ranks. The investigation was then extended to spinning; of sixty-five directors of cotton mills, approached by letter, returns were received from forty-five, of whom thirty-three were self-made men. Moreover, a spinning district was visited and a direct investigation was made, which showed that 13 per cent. of the managing directors, 42 per cent. of the mills managers, and 67 per cent. of the assistant managers, came from working-class families or families with incomes about the same as those earned by the operative classes. Having reached these suggestive percentages, the authors of the paper turned their attention to the manner in which the industrial ladder can be climbed in Lancashire by people without capital or influence. It was shown that in manufacturing the small firm still survives. Of the 134 private businesses (manufacturing only) in Bolton, Rochdale, Leigh and Atherton, Burnley and Todmorden and Cornholme, four have less than 50 looms, five have from 50 to 100 looms, eight from 100 to 150 looms, five from 150 to 200 looms, and four from 200 to 250 looms. In spinning, the joint-stock system largely prevails—of 145 spinning firms in a sample district, 135 were public companies, while of sixty-five manufacturing firms, only twenty-three were of that type of organisation —but within businesses of the public joint-stock order progression takes place, so that the man of great capacity may rise to any position. Further, the authors drew attention to the system of renting premises and power (in manufacturing), the selling of machinery on credit and even for part payment in shares, the obtaining of capital in the form of share capital, and the loans to mills which are so popular in Lancashire and are advertised for in the papers like the loans sought by public authorities. Moreover, the recruiting of the employing class takes place to some extent, it would seem, through the commercial classes. The relations of trade unions and of education to the vertical mobility of labour were examined, and it was concluded that the charge that the former gravely retarded vertical mobility had not been substantiated, as regards Lancashire, while emphasis was laid on the latter as a direct contributory cause of advancement from one grade to another. The authors maintained that vertical mobility was to be encouraged in the interests both of the operative classes, whose wages it tended to elevate, in addition to furnishing prospects conducive to hopefulness, and of the community as a whole.

* Abstract of a paper by Professor S. J. Chapman and Mr. F. J. Marquis, recently read before the Royal Statistical Society.

THE HARVESTING OF SUGAR-BEET IN FRANCE.

The harvesting of the sugar-beet in France is usually commenced about the middle of September. It is generally over in a few weeks as it is desirable to expose the soil, as long as possible, to the action of the weather and to prepare the land for the next crop. Another reason is, that if left too long in the ground, the plants are liable to run to seed, and in so doing the roots are deprived of some of their sugar. It is also important to clear away the crops before the early frosts set in, which would be injurious to the roots and detrimental to their yield. Experience is required in order to determine exactly the right moment for taking up the roots. Generally speaking, as soon as the leaves begin to lose their vitality and their dark-green colour, and turn yellow, they should be removed from the ground.

The harvesting of the sugar-beet consists of two different operations, viz., the extraction of the roots from the soil (*arrachage*), and the *décolletage*, or the slicing off, of the tops of the roots, together with the leaves. This part of the root, although containing a certain percentage of saccharine matter, is quite useless for sugar-making, on account of the amount of saline substances found in it. For this reason, in contracts between the grower and the manufacturer, it is usual to stipulate

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that a generous slice from the top of the beet be taken off before delivery at the works.

The rooting-up of the roots (*arrachage*) is effected in France either by manual labour (*arrachage à bras*), or by mechanical means (*arrachage mécanique*). For the first, which is only practised on small holdings, the labourer simply loosens the soil close to the root with a two-pronged fork, then, taking hold of the plant with both hands, he draws it out of the ground, shaking it at the same time to get rid of any earth or small stones, adhering to it. This is a very slow process, occupying one man from 110 to 130 hours labour per hectare (45 to 55 hours per acre).

The roots are laid on their sides in rows in readiness for the *décolleteurs*, who, armed with knives or other cutting implements, slice off the tops. The roots are then placed in heaps and covered with leaves, in readiness for cartage to the sugar factory. In this way they lose some of the moisture they contain, and decrease in weight. For this reason, the owners of the sugar factories usually stipulate that the beet should not be delivered until forty-eight hours at least after being taken out of the ground.

Harvesting by hand labour has the disadvantage that portions of the roots are liable to break and get left in the ground, and so diminish the value of the crop to the farmer.

The appliances used in France for the harvesting of the sugar-beet by mechanical aid, may be divided into two classes, viz.:—

1. Animal traction;
2. Mechanical traction.

The machines drawn by animals are only suitable for extracting one row, or at most two or three rows of beet, each journey up and down the field, whilst those propelled by mechanical aid are suitable for drawing five to ten, or even twelve rows, at the same time.

The amount of work accomplished by machines drawn by animal power (*arracheuses à traction animale*), may be estimated as follows:—

1 row at time, $\frac{3}{5}$ hectare per day (about $1\frac{3}{5}$ acres)
3 rows „ $1\frac{1}{3}$ „ „ („ $3\frac{1}{3}$ „)

whilst those driven by machinery (*à traction mécanique*), working on eight to ten rows simultaneously, and drawn to and fro with a cable by two powerful traction engines from each side of the field, will clear as much as 10 hectares (nearly 25 acres) per day.

The power required for driving these machines varies considerably. In dry weather, or after a frost, more power is usually necessary. Under ordinary circumstances two horses or a pair of oxen are sufficient for a one-row machine, whilst in very dry weather three or even five pair may be found necessary.

The machines propelled mechanically in use at the present time are of two types:—

1. Those by which the ground is loosened by means of "colters" to some depth below the roots, which are then, by some suitable mechanism, pulled out of the ground (*arracheuses fouilleusés*).

2. Those by which the ground is only slightly moved (*arracheuses non-fouilleuses*), and the roots seized by some arrangement for drawing them out of the soil.

The machines of Fowler, Candelier, Bajac, Amiot, etc., belong to the first type, whilst the second are represented by the machines of Frennet-Wauthier, Pruvot, etc.

HOME INDUSTRIES.

Railway Dividends.—It is not likely that the railway dividends for the second half of 1911 will be generally increased as compared with the corresponding period of 1910, but the past half year was an exceptionally prosperous one, notwithstanding the labour troubles. Gross earnings largely increased, coal was relatively cheaper, and the better methods of operation recently adopted, and the co-operative arrangements come to in the past two or three years, have conduced to the improved results. Then the capital outlay, which used to average about £20,000,000 per annum, has been reduced to from four to six millions per annum, so that there is very small increase in capital charges. But although profits would, taken by themselves, warrant improved distribution, it may be expected that, having regard to the labour outlook, and what it may involve, most of the companies will maintain, but not increase, the distribution they made for the second half of 1910, carrying the additional profits earned to reserve for contingencies. It must not be forgotten that the new rate of wages, which brings up the minimum wage to £1 per week for practically all grades, prevailed for only a few weeks of the past half year, so that the increase in the wages bill—including the increased expenditure incurred during the strike period—for the six months is not likely to be a large one as it must be in the current half year. Then, again, the trouble amongst the miners, however it may end, is pretty certain to put up the price of coal, a very serious matter for railway shareholders. On the other hand, given normal conditions, it may be expected that the activity of trade, and the increased spending power of the community, will result in a large increase in gross earnings in the current year. The figures for the past half year show that the gross earnings of the nineteen principal English railway companies have increased about 2·3 per cent., while for the twelve months the increase has been about £2,700,000, or 3 per cent., about 40 per cent. of the increase being in passenger earnings. It may be noted that the South-Eastern has done exceptionally well with an increase of £86,000 in gross earnings, equal to 3·3 per cent.

Useless Patents.—A case recently decided by Mr. Justice Parker seems to show that it is too easy in this country to obtain patents which cannot be sustained, but whilst in existence operate as a check upon legitimate enterprise. The patent in

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question was one (number 27,147 of 1910) granted to Mr. J. C. Merryweather for improvements in automobiles carrying pumps, and the alleged invention appears to have consisted in driving the pump by means of a chain. Messrs. Hans Renold, Limited, who are manufacturers of driving chains, applied to have this patent revoked, claiming that the mere substitution of chain driving for some other method of driving, such as by belt or spur gearing, in connection with any particular class of machines, was not proper subject-matter for a patent. It was, they contended, a substitution already made in connection with many different machines, and one which might hereafter be made in connection with many others. To grant patents in such cases would, it was urged, hamper the development of the chain-making industry, and they accordingly petitioned for the revocation of the patent on the ground of want of novelty, prior publication and use, and that the alleged invention was not a proper subject-matter for a patent. When the case came on the patentee consented to the revocation of the patent, but on the question of costs raised an objection that the petitioners had given no notice to him of their intention before commencing proceedings. If they had done so, he contended, he might have surrendered the patent and saved some expense. The Judge, however, allowed the costs of the petition, remarking that it is doing a kind of public wrong to maintain a patent on the rolls when that patent is void.

Trade with Russia.—According to the German-Russian Union report recently issued, which deals with the Russian foreign trade, German trade with Russia is increasing much more rapidly than that of any other country. The total imports into Russia for the first eight months of 1909 were 505 million roubles, during the same period in 1910 they were 630 million roubles, and for this period last year 679 million roubles. The following table shows the value supplied by the principal countries during these periods:—

	Value in million roubles.		
	1909.	1910.	1911.
Germany	230	285	313
Great Britain	84	106	102
United States	36	52	73
France	32	39	35
Austria-Hungary	18	24	23
Italy	7	12	12
Belgium	4·7	4·6	4·3

Perhaps the greater interest now being taken by English financiers in Russian matters may quicken exports from England to Russia before long.

Over-Insurance.—Of late years we have not heard very much about over-insurance, but it is to be feared it is still very common. A case that has just been investigated at Cardiff deserves attention. It was that of a steamship which had been worked at a loss. The total insurance effected on the vessel amounted to £17,800. The value put upon her by the managing owner at the time of her loss was about £8,700. Having regard to her age (twenty-two years), and her build, tonnage and condition, the Court found that her value at the time of her loss was £7,000 for hulk and machinery, £550 for disbursements, and £450 for premium, reducing the value to a total of £8,000. Thus the vessel was over-insured at the time of her loss to the extent of £9,800. The Court further found that the vessel was insufficiently and inefficiently manned for the voyage; that on the night when she went down the watertight doors were not closed, that she might have got much nearer shelter, if not to a place of safety, if the engines had been kept, as they ought to have been, at full speed, and that "neither the master nor the engineer desired to save the vessel."

Cotton Ginnings.—The eighth cotton ginning report of the United States Government shows that up to January 1st the ginnings were 14,332,000 bales as compared with 12,465,298 bales of the 1908–9 record crop. If this margin of 1,867,000 bales is added to the commercial crop (13,829,000 bales) of the year it will give 15,696,000 bales, and as the rate of ginning between December 13th and January 1st this season was still a little ahead of that for 1908–9, this total is quite possible. But the percentage ginned on January 1st, 1909, was rather lower than usual, and the next ginning period may fall behind. But the expectations of a great crop are already fulfilled.

CORRESPONDENCE.

INDIGO STANDARDS.

My attention has been drawn to a paragraph in *The Indian Planters' Gazette* of December 23rd, 1911, quoted from the *Journal of the Royal Society of Arts*, of the first idem, to the effect that a "special committee was about to be formed with the Textile Institute to consider the question of fixing a recognised standard of indigo-blue dyes in cloth, etc."

As I have made a special study of indigo since 1897, when the "synthetic indigotin" was first placed upon the market, I should like, with your permission, to offer a few observations on the subject. The first objection I have to make is that some foreign commercial chemists and their coadjutors declare that "synthetic indigotin" is indigo, which is an impossible absurdity, as it consists of indigotin only, whereas natural or plant indigo contains several ingredients, including indirubin, which do not exist in "synthetic indigotin," and are falsely called "impurities," as I shall explain presently. "Oh, but," someone may say, "indigotin is the sole colouring matters of indigo, and indigotin is therefore indigo pure." I say that it is not. Colour dyers will tell you, as they have told me, that they do not find much difference between "synthetic indigotin" and indigotin exracted from indigo, but they find a vast difference

between "synthetic indigotin" and indigo. All practical dyers also admit that the other ingredients in indigo (made apparent by chemicals), add to the colour-producing power of indigo, and one of the most expert dyers in the country—Mr. Alex. W. Playne, of 9, Stanley Street, Bedford—holds that the whole of a sample of indigo dyes blue, and that the chemicals only spoil it, as it is very sensitive to chemicals. One can understand that from its composition. They also say that changes take place in the vats which enhance the dyeing power of indigo. Prior to 1902, all the "synthetic indigotin" made from coal tar, imported into this country, was under the heading of "other coal tar dyes"; but since that year, it appears on the Returns of the Board of Trade as "synthetic indigo." Now there is not such a thing in existence as "synthetic indigo"; at best it can only be "synthetic indigotin," neither is it "indigo pure," or "indigo rein." All these false descriptions should be absolutely prohibited by all scientific men, and independent journals in this country. Another aspect of these foreign dyes, which are imported into this country, is that many of them are passed off on the public as indigo. Faked mixtures of alzarine, aniline and logwood are topped with a minute quantity of indigo, and often none at all, and sold as "indigo dyed." But that is not the worst; dealers and consumers having been told that indigotin is the sole colouring matter of indigo, they now will not buy any except upon its "indigotin content" test, and here there is room for an unlimited amount of fraud, as the test applied—viz., the potassium permanganate titration test—is essentially a false test, hence the party testing with it has unlimited scope for depreciating a proprietor's indigo, when he is *not* present; and when testing it for dealers and consumers the same objection exists. One of the most serious objections to this test is that the indigo is subjected to over seventy times its weight of fuming sulphuric acid, which utterly destroys its characteristic quality, its fastness, and the indigo having been converted into sulp-indigotic-acid, it can never be recovered as the same indigo again. But this is not all; Mr. W. P. Bloxam, B.Sc., who carried out research work at the Clothworkers' department of the University of Leeds for the Government of India some years ago, declared that "at no amount of dilution whatever was 1 c.c. of $\frac{N}{50}$ permanganate solution equivalent to 0·0015 gram of indigotin." Besides the above, the potassium permanganate is a very unstable compound, and requires to be constantly standardised, and indigos that test by it below 60 per cent. are often first-class vat indigoes. The most extraordinary thing is that neither chemists, brokers, dealers, buyers, nor consumers, have ever recommended the only true test for indigo as for all dyes, viz., the *dye test*. They will not employ it, but go on with the titration test, as they know that by it they can cheat the owners, whereas by the dye test they could not, as all honestly made indigoes dye very much alike, especially of the Bengal marks. I have got a lurking suspicion of the term "indigo blue." What is "indigo blue"? You can have a hundred shades of indigo blue, according to the percentage of indigo and rouses used on the cloth, and tradesmen call any blue they can sell, "indigo blue." Flour and sulphate of copper make a blue colour, which is often sold as a navy blue serge. "Synthetic indigotin" only dyes a sky blue, or china blue, and it is only when faked that it can approach natural indigo. I therefore hold that if "synthetic indigotin" is to be designated "indigo," and allowed to rank as a standard of indigo blue, it should be considered a gross injustice to the natural dye, and a great injury to hundreds of British subjects, who have been nearly ruined by these importations of fugitive and foreign dyes.

K. N. MacDonald, M.D.

ILLUMINATED MANUSCRIPTS.

I find that, speaking without preparation at the meeting on the 17th inst., I made the unpardonable blunder of describing the service of "Tenebrae," when talking of the "Exultet" Rolls of the eleventh to thirteenth centuries. They are connected with the service of the consecration and lighting of the Paschal candle on Easter Eve. The mistake, however, does not affect the point I raised as to the place these rolls hold in the history of the development of Italian art.

Robert Steele.

OBITUARY.

James Sewell Neville.—Mr. James Sewell Neville, of Sloley Hall, Norwich, died on the 16th inst., at the age of eighty-four. After being educated at Cambridge, he was called to the Bar in 1852. For some time he was Advocate-General of Bombay, and from 1876 to 1882 a Judge of the High Court of Judicature at Calcutta. He assumed, by Royal licence, the name of Neville in lieu of White in 1885. Mr. Neville joined the Royal Society of Arts in 1883; he served on the Council from 1896 to 1898, and on the Indian Section Committee from 1896 to 1901; and he took part in discussions on several occasions.

NOTES ON BOOKS.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe, C.B., LL.D., F.R.S. Revised and enlarged Edition. Vol. I. London: Longmans, Green & Co. £2 5*s*. net per volume.

The new issue of Thorpe's "Dictionary of Applied Chemistry" is to consist of five royal octavo volumes, each of which is priced at £2 5*s*., and it is hoped that the whole work will be completed

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within two years from the issue of the first volume, now under review.

In the first volume, which comprises 758 pages, and includes the alphabetical sequence as far as Chestnut Extract, there are many articles on important branches of applied chemistry, these articles being comprehensive, concisely worded, well up to date, suitably illustrated and furnished with references calculated to assist the reader in making further investigations. As examples of such admirable articles, may be mentioned that on Ammonia by Dr. Harold G. Colman, that on Bread by Dr. E. F. Armstrong, that on Brewing by Mr. John Heron, and that on Bromine by Dr. Rudolf Lessing.

As a contrast with the comprehensive articles mentioned above, there are others that are rather short, notably Dr. Robert Schüpphaus's article on Celluloid, which is comprised in less than a page, and is chiefly a reference to one American system of making and working a celluloid mass. There are no references to handbooks, papers, or patent specifications, no mention of film making or the various recent uses of liquid or semi-liquid preparations, and, as far as this article is concerned, amyl acetate, acetone, and some of the solvents that have been more or less recently introduced, might be non-existent. Another example of brevity is afforded by the four lines devoted to Salt Bittern. Considering the great present importance of bitterns as sources of magnesium compounds, bromine and iodine, a condensed tabular statement of the composition of the chief bitterns might have been given, or, failing this, a reference to some source of information, as for example the concise table on p. 220 of Ratton's "Handbook of Common Salt," or the more elaborate tables in the "Salz - bergbau und Salinkunde" of Fürer.

Other articles are perhaps somewhat overloaded with subjects that may be regarded as a trifle outside the legitimate scope of a work on applied chemistry, as for example two pages about Agate, the matter being mainly geological, but about one third of the article is devoted to details of the work of the lapidary. Another instance of what may perhaps be regarded as redundancy, is about five pages on the various methods of mechanically forming or moulding candles, and the extent to which the chemical is made to cede to the mechanical is well illustrated by the fact that it is considered worth while to give an illustration and special description of the well-known self-fitting candle with a truncated and fluted conical end; indeed, more than this, even the machine for moulding this form is described and figured.

Since the last edition of Thorpe's "Dictionary of Applied Chemistry" made its appearance, a new difficulty has arisen for those who are fated to compile chemico-technological works. The Sale of Goods Act of 1894 so far modified the old common law doctrine of implied warranty as to lay it down by statute law that in the case of a simple contract for the sale of a specific article under its patent or other trade name, there is no implied warranty as to its fitness for any particular purpose.

At any rate *post hoc*, and probably also to a great extent *propter hoc*, a host of special or trade names has arisen. For example, sodium perborate is now largely manufactured and is sold as a bleaching agent for laundry use. If a person purchases sodium perborate, there is an implied warranty that the material is fit for all uses for which sodium perborate is fit. As a matter of fact, sodium perborate is now sometimes sold under the trade or special name of "perborin," also as "perborin, M.," and possibly under a dozen other trade designations. By the statute referred to, such trade designations in themselves carry no warranty, although by express act or agreement a warranty may be associated with the trade term.

The editor of such a work as Thorpe's "Dictionary of Applied Chemistry" is confronted with the alternative of only using systematic and recognised names for substances, or of endeavouring to include the new special or trade terms. One may reasonably say "endeavouring," for to include all the trade terms as applied to chemicals and mixtures is obviously impossible, as trade terms appear and disappear, and also occasionally take new or modified meanings.

In the work before us, the attempt has been made to include trade terms. Thus, under the heading Antidiabetine we find this definition: "Trade term for a preparation said to be composed of saccharin and mannite." Antiseptine, we learn, "is said to be a mixture of zinc iodide, zinc sulphate, boric acid, and thymol." If it is the function of a work like that before us to publish a conjecture as to the composition of some proprietary medicines or preparations, it is difficult to see why others should not be included. Antigermin is included, and it is vaguely described as, "A preparation of a copper salt of a weak organic acid mixed with lime." The next following article is on Antihypo, and this is said to be, "A solution of potassium percarbonate, used for destroying sodium thiosulphate in photographic negatives and prints." It is difficult to see how this can be correct, as the solution of potassium percarbonate decomposes with effervescence spontaneously at the ordinary temperature. The use of the solid potassium percarbonate, added to the wash water, is known to every photographer. Pages might be filled with comments on the special or trade names, and the uncertain, shifting, or unsatisfactory nature of the available information.

The new edition of Sir Edward Thorpe's "Dictionary of Applied Chemistry" should take a place among the technological classics of the time, and doubtless it will be much sought after as a book of reference in public libraries. At the same time, in compiling the volumes to come, it may be well to remember that the special article of an eminent contributor may sometimes require

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pruning and sometimes supplementing; further, a watchful and careful sub-editing, if practicable by one individual, may be an important factor if trade designations and proprietary medicaments are to be included.

GENERAL NOTES.

Professor Boys's Juvenile Lectures.—Mr. Carmichael Thomas, on behalf of the proprietors of the *Graphic*, has presented to the Society the original of the drawing by Mr. Arthur Garratt of Mr. Charles Vernon Boys, F.R.S., delivering a juvenile lecture on "Soap Bubbles" at the Royal Society of Arts. The picture appeared as a full-page illustration in the *Graphic* of January 20th, 1912.

Ancient Workers in Copper.—In the course of his inaugural address, as President of the Institute of Metals, Professor William Gowland, F.R.S., spoke of the early history of copper and its alloys. He said so momentous a discovery as that of metals contained in ores must have had its origin in the domestic fires of the Neolithic Age. The camp fire was, in fact, the first metallurgical furnace, and from it, by successive modifications, the huge furnaces of the present day had been gradually evolved. Furnaces of primitive form survived in Derbyshire up to the seventeenth century. In Japan the furnace for smelting copper, tin, and lead ores, which was a mere hole in the ground, was in universal use there up to 1858, and was still extensively employed. It was as simple as that of the Bronze Age. There was abundant evidence to show that Egypt was the first in the field in artistic bronze casting. The fall of Greece and the rise of the supremacy of Rome was the dawn of an important period in the history of copper and its alloys. In Spain and in Britain copper-smelting was vigorously carried on by the Romans. The Romans were the first makers of brass. Although they were unacquainted with the essential constituent, zinc, yet they discovered that, by melting copper altogether with a certain ore (calamine), a yellow alloy of a more golden colour than bronze could be obtained. The process was so effective that, until a comparatively recent period, all brass was made in Europe by the ancient process, and even until a few years before 1861 it was thus made in Birmingham. The survival of this ancient process afforded a striking example of the conservatism characteristic of British metallurgy. With the disappearance of the calamine brass, one of the last links in the chain connecting the modern metallurgy of copper and its alloys with antiquity was broken. An important link, however, still remained in the process *à cire perdue* of casting bronze, a process in which it could hardly be said that we were any further advanced than the Greek founders of some centuries before our era. Further, it should not be overlooked that the principles on which copper refining is based were carried out in practice in the time of Pliny.

Photographic Exhibition.—A collection of pictorial photographs is now on view, and will remain open till February 24th, at the house of the Royal Photographic Society, 35, Russell Square. Admission is free to the public on presentation of visiting card. The photographs are by members of societies affiliated to the Royal Photographic Society, and have been selected as being the best work produced by each society.

Consumption of Algerian Grapes in Paris.—The *Bulletin du Gouvernement général de l'Algérie* states that the total quantity of grapes grown in that colony and sold last season at the Halles Centrales of Paris amounted to 1,113,000 kilograms (2,254,165 lbs.) as compared with 1,157,180 kilograms (2,551,582 lbs.) in 1910. At the commencement of the season which lasted from July 13th to August 14th, the first consignments (which were small) realised between 2 francs and 2·40 per kilogram (9*d*. to 11*d*. per lb.), whilst the prices towards the end of the season ranged from 20 to 60 cents per kilogram (less than 1*d*. to 2¾*d*. per lb.). The largest quantity sold on any single day was 74,940 kilograms (165,241 lbs.).

Silk Production in Italy.—The Italian cocoon crop of 1910 amounted to 22,658,000 pounds as compared with 21,870,000 pounds in 1909 and 27,933,000 pounds in 1908. The crop of Piedmont in 1910 was a little over 10 million pounds as against 9 millions in 1909, and 15 millions in 1908. In 1910, as in 1909, Piedmont, instead of producing, as usual, more than one half of the total Italian crop, produced so small a quantity as greatly to diminish the total crop of Italy. The failure of the Piedmontese crop was due in part to the cold and rainy weather of the spring months which affected the growth of mulberry leaves, and in part to the *Diaspis pentagona*, which made its appearance early in the spring and caused considerable damage. The quality of the crop was, however, satisfactory, and was richer in silk than the crop of 1909.

The Aerial Fleet of Germany.—The largest fleet of dirigibles in Europe at the present time is that of Germany, which numbers seventeen. Of these, eleven belong to the army, and six are private. There are also nine more in course of construction, so that by the spring Germany will have a fleet of twenty-six of these airships—a number greater than those possessed by all the other European Powers together. The number of dirigibles owned by France is ten, by Russia five, Austria-Hungary four, Spain and Italy two each.

Mussel Mud as a Fertiliser in Canada.—In most of the bays indenting the shores of Prince Edward Island are found extensive deposits of mussel mud, so called locally, being organic

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remains of countless generations of oysters, mussels clams, and other shell-fish. The shells, usually more or less intact, are found embedded in dense deposits of a mud-like substance, and this combination is a fertiliser of high value and potency. It supplies lime and organic matter, besides small quantities of phosphates and alkalies. An ordinary dressing of it secures fertility in a striking manner to the poorest or most exhausted soil. The shells decay slowly, year by year, throwing off a film of fertilising stuffs. The deposits round Prince Edward Island vary from five to twenty-five feet in depth. They are taken up by dredging machines, worked from rafts in summer or from the ice in winter.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

January 31.—Professor G. W. Osborn Howe, M.Sc., M.I.E.E., "Recent Progress in Radio-Telegraphy." Sir William H. White, K.C.B., F.R.S., will preside.

February 7.—Leonard Hill, M.B., F.R.S., and Martin Flack, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation."

February 14.—Cecil Thomas, "Gem Engraving." Sir Arthur John Evans, D.Litt., LL.D., F.R.S., will preside.

February 21.—Frank Warner, "Silk." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

February 28.—H. A. Roberts, M.A., "The Relations of Science to Commerce and Industry." Principal Sir Henry A. Miers, M.A., D.Sc., F.R.S., will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

February 8.—Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India." Sir Frederic W. R. Fryer, K.C.S.I., formerly Lieutenant-Governor of Burma, will preside.

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

April 25.—Walter Saise, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

January 30.—W. A. Legg, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony, "Irrigation in South Africa." The Hon. Sir Richard Solomon, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, will preside.

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Cantor Lectures.

Monday evenings, at 8 o'clock:

Vaughan Cornish, D.Sc., F.G.S., F.C.S., "Ocean Waves, Sea-Beaches, and Sandbanks." Two Lectures.

Syllabus.

Lecture II.—January 29.—The action of waves and tidal currents on sea-beaches and sandbanks—The proper action of waves to drive sand and shingle shoreward—The proper action of waves to drive mud seaward—Special conditions under which the action on sand is reversed—The proper action of the tide to drive shingle in the direction of the flood—The normal removal of shingle from promontories and its accumulation in bays—The exceptional accumulation of shingle in salient positions, *e.g.*, at Dungeness—Groynes—The reason of the graded arrangement of shingle on the Chesil beach—The formation of a sandbank on the up-channel side of a promontory—Sandbanks in estuaries and their arrangement by tidal currents—Their rippled surface as a means of mapping these currents—Their influence on the formation of tidal bores—The struggle between land water and tidal water to arrange the sandbanks in the Severn—The variability of the Severn Bore as determined by these factors—The circumstances which determine the starting point of the Severn Bore.

Loudon M. Douglas, F.R.S.E., "The Meat Industry." Three Lectures.

Syllabus.

Lecture I.—February 5.—The Bullock and its Products.

Lecture II.—February 12.—The Sheep and its Products.

Lecture III.—February 19.—The Pig and its Products.

Luther Hooper, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

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NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. Vaughan Cornish, "Ocean Waves, Sea-Beaches and Sandbanks." (Lecture II.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. J. C Newsham, "Farm Institutes in Relation to Agricultural Education."

Geographical, Burlington-gardens, W., 8.30 p.m. Professor Norman Collie, "Explorations in the Canadian Rockies."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Mr. G. E. May, "The Investment of Life Assurance Funds."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor Sir Walter Raleigh, "The Writings of Sir George Savile, Marquis of Halifax."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. A. G. R. Mackenzie, "That Modern House-Planning tends to be Over-elaborate."

TUESDAY, JANUARY 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. W. A. Legg, "Irrigation in South Africa."

Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Captain A. St. John, "The Community and its Children: their Co-operation in their own Training."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. R. J. Durley, "The Central Heating- and Power-Plant of McGill University, Montreal."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. J. McIntosh, "Sylvan Essex; its Bye-ways and Water-ways."

WEDNESDAY, JANUARY 31...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor G. W. Osborn Howe, "Recent Progress in Radio-Telegraphy."

King's College, Strand, W.C., 5 p.m. Dr. J. Paul Richter, "The Art of the Catacombs."

Sanitary Engineers, Caxton Hall, Westminster, S.W., 8 p.m. Presidential Address by Mr. A. J. Martin.

Automobile Engineers, Connaught Rooms, Great Queen-street, W.C., 8 p.m. Discussion on "Self-Starters for Internal-Combustion Engines."

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Mr. H. G. Keene, "Home Rule for India."

THURSDAY, FEBRUARY 1...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Professor A. Forel, "Fourmis des Seychelles reçues de M. Hugh Scott." 2. Mr. F. W. Edwards, "Tipulidæ from the Indian Ocean." 3. Dr. Gunther Enderlein, "Sciaridæ, mit einem Anhang von Dr. J. J. Kieffer (Beschreibung neuer Sciariden von den Seychellen Inseln)." 4. Mr. C. Morley, "Ichneumonidæ from the Indian Ocean." 5. Mr. C. Tate Regan, "New Fishes from Aldabra and Assumption, collected by Mr. J. C. F. Fryer."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. Tutin and H. W. B. Clewer, "The Constituents of Commercial Chrysarobin." 2. Messrs. R. L. Taylor and C. Bostock, "Researches on Bleaching Powder. Part. II.—The Action of Dilute Acids on Bleaching Powder." 3. Mr. H. Hibbert, "The Quantitative Estimation of Hydroxy-, Amino-, and Imino-Derivatives of Organic Compounds by means of the Grignard Reagent, and the Nature of the Changes taking place in Solution." 4. Mr. A. C. Dunningham, "An exact Investigation of the three component system—Sodium Oxide, Acetic Anhydride, Water."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. M. Greenwood, "Plague—its Origin and History."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. M. Worthington, "The Phenomena of Splashes." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. Vaughan Cornish, "The Panama Canal."

FRIDAY, FEBRUARY 2...Royal Institution, Albemarle-street, W., 9 p.m. Sir James Mackenzie Davidson, "Vital Effects of Radium and other Rays."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Captain H. R. Sankey, "Steam Turbines: Some Practical Applications of Theory." (Lecture I.)

SATURDAY, FEBRUARY 3...North-East Coast Institute of Engineers and Shipbuilders, Technical College, Sunderland, 7.30 p.m. (Graduates' Section.) Mr. F. W. Dugdale, "The Growth of the Steam-Engine."

Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander C. Mackenzie, "Russian Music of To-Day."

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Journal of the Royal Society of Arts.

No. 3,089. VOL. LX.

FRIDAY, FEBRUARY 2, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 5th, 8 p.m. (Cantor Lecture.) LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." (Lecture I.)

WEDNESDAY, FEBRUARY 7th, 8 p.m. (Ordinary Meeting.) LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation." LORD SANDERSON, G.C.B., K.C.M.G., Chairman of the Council, will preside.

THURSDAY, FEBRUARY 8th, 4.30 p.m. (Indian Section.) COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-Eastern Frontier of India." SIR FREDERIC W. R. FRYER, K.C.S.I., formerly Lieutenant-Governor of Burma, will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, January 29th, MR. VAUGHAN CORNISH, D.Sc., F.G.S., F.C.S., delivered the second and final lecture of his course on "Ocean Waves, Sea-Beaches, and Sandbanks."

On the motion of the Chairman a vote of thanks was accorded to Dr. Vaughan Cornish for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, January 30th; the HON. SIR RICHARD SOLOMON, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, in the chair. A paper on "Irrigation in South Africa" was read by MR. W. A. LEGG, M.Inst.C.E., late Supervising Engineer, Irrigation Department, Cape Colony.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on January 18th, 1912. In the unavoidable absence of Sir James A. Bourdillon, K.C.S.I., SIR KRISHNA GOVINDA GUPTA, K.C.S.I., occupied the chair.

The paper read was—

THE OLD DISTRICT RECORDS OF BENGAL.

By the REV. WALTER K. FIRMINGER, B.D.,
Senior Chaplain, H.M.'s Bengal Establishment.

In nearly all of the older chief Government offices of the districts of Bengal there are to be found presses containing records of the British administration of the several districts, and these travel back in age frequently to the days of Warren Hastings, and in at least two instances to those of Lord Clive. Of these rural records, their character, their present condition, and their value as materials for history, it is my privilege to speak this evening. Sir William Hunter, in his charming way, has thus described these collections: "They consist of reports, letters, minutes, judicial proceedings, and relate, in the words of eye-witnesses, and with official accuracy, the daily history of the country from the time the English took the administration into their own hands. Many of them are written in the curt, forcible language which men use in moments of excitement or peril; and, in spite of the blunders of copyists and the ravages of decay, they have about them that air of real life which proceeds not from literary ability, but from the fact that their authors' minds were full of the subjects on which they wrote. We learn from these worm-eaten manuscripts that what we have been accustomed to regard as Indian history is a chronicle of events which hardly affected, and which were for the most

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part unknown to, the contemporary mass of the Indian people. On their discoloured pages the conspicuous vicissitudes and revolutions of the past (*i.e.*, the eighteenth) century have left no trace. Dynasties struggled and fell, but the bulk of the people evinced neither sympathy nor surprise, nor did the pulse of village life in Bengal move a single beat faster for all the calamities and panics of the outside world. But these volumes, so silent on subjects about which we are already well informed, speak at length, and with the utmost precision, on matters regarding which the Western world is profoundly ignorant. They depict in vivid colours the state of rural India when the sceptre departed from the Mussulman race. They disclose the complicated evils that rendered our accession for some time an aggravation rather than a mitigation of the sufferings of the people. They unfold one after another the misapprehensions and disastrous vacillations amid which our first solid progress was made. They impartially retain the evidence of low motives and official incompetence side by side with the impress of rare devotion and administrative skill. But, taken as a whole, they reveal the secret of England's greatness in the East. They exhibit a small band of our countrymen going forth to govern an unexplored and a half-subdued territory. Before the grave heroism and masterful character of these men, the native mind succumbed. Our troops originated for us a rude Mahratta-like supremacy; but the rural records attest that the permanent sources of the English ascendency in Bengal have been, not their brilliant military successes, but deliberate civil courage and indomitable will."*

In this passage, Sir William Hunter has shown far more graphically than I could do in words of mine own, what is the real interest of the old Collectorate records, and I venture to think you will agree with me that the passage I have quoted is of peculiar interest, when we remember that Sir William Hunter's "Annals of Rural Bengal" was published, and in four months passed through three editions, in 1868—nearly six years before the publication of John Richard Green's "Short History of the English People." It is surely not too much to say that Hunter, in the "Annals," applied to Indian history that conception of the history of a people or peoples which at a later date made Green's "Short History" mark an epoch in historical science. No doubt some of the details of Sir William's statement which I have quoted are open to dispute; but the passage, as a whole, affords a clear view of the general nature of the records we are concerned with this evening.

* Hunter, "Annals of Rural Bengal," pp. 7, 8.

On an earlier page, Sir William tells us how he made his first acquaintance with these district records he so skilfully employed in the making of his book. "In taking over charge of the District Treasury," he writes, "I was struck with the appearance of an ancient press, which, from the state of its padlocks, seemed not to have been opened for many years, and with whose contents none of the native officials were acquainted. On being broken open, it was found to contain the early records of the district from within a year of the time that it passed directly under British rule. The volumes presented every appearance of age and decay; their yellow-stained margins were deeply eaten into by insects, their outer pages crumbled to pieces under the most tender handling, and of some the sole palpable remains were chips of paper mingled with the granular dust that white ants leave behind. Careful research has convinced me that these neglected heaps contain much that is worthy of being preserved. For what trustworthy account have we of the real state of India at the commencement and during the early stages of our rule? Eloquent and elaborate narratives have indeed been written of the British ascendency in the East; but such narratives are records of the English Government, or biographies of the English Governors of India, not histories of the Indian people. The silent millions who bear our yoke have found no annalist."*

Here, again, I find in Sir William's book far better words than I could supply to describe the actual condition of a great part of the records. "Yellow-stained margins," "pages crumbling to pieces under the most tender handling," "chips of paper mingled with the granular dust that white ants leave behind"—of all these I had a liberal experience when the precious Midnapur Records were entrusted for a short time to my care for purposes of research. In 1904, Mr. A. P. Muddiman, I.C.S., had made an examination of these particular records, and then he wrote: "The original letters, if kept any longer in their present form, will crumble to dust almost at once. They are of various sizes and shapes, and are bound up with particular care. Many are torn, and every time the volume is opened they are bound to be damaged. Torn pieces of the letters are simply placed in the volume hap-

* Hunter, "Annals of Rural Bengal," p. 5.

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hazard, and are exceedingly liable to be lost." Of six volumes of letters received, dated respectively 1764, 1765, 1766, 1767, 1768, 1769, I was only able to see the last five, and these were in reality no longer bound volumes, but heaps of decaying paper tied up between boards, the original stiffening of the covers, with leaves overlapping and breaking off at touch. Before venturing to read the papers, I sought and obtained the permission of the Bengal Government to detach each letter from its heap and place it in a separate paper cover, on which the date and a *précis* of its contents could be written. Having done this, I proceeded to make a copy of the letters, inserting in due place copies of letters from a large and dilapidated volume of letters received.* Some 200 of these letters, chiefly those relating to military expeditions in the jungles to the west of Midnapur, were published, by kind permission of the Government of Bengal, in "Bengal: Past and Present," the organ of the now dying Calcutta Historical Society.

It must not, however, be inferred that the work of recovering these venerable records for purposes of historical science in every case necessitates these difficult and, for the private student, costly operations. At Sylhet, for instance, I found that the oldest records were in a far more legible condition than copies made from them in comparatively recent years by a Collector (E. J. Barwell), who wisely held that the old papers, although themselves not originals but copies, were worthy of editing and publication. Our great-grandparents in Bengal were exceedingly fortunate in the ink they employed; their early training included the art of beautiful writing, and the foolish fashion of unintelligible signatures was practically non-existent. Age in itself does not account for the decay of papers, even in Bengal.† The preservation of records in Eastern India depends mainly on the nature of the paper—its capacity or non-capacity for resisting damp, the height which bound volumes are kept from the ground, the access which is granted to readers at the record rooms, and many other circumstances quite independent of antiquity. It must be remembered, especially when the word "neglect" is employed, that a volume, which for centuries has remained fair and legible, may, despite the watchfulness of ages, be ruined in a single night by insects or by mice. In the new Province of East Bengal and Assam, the great earthquake of 1897 dealt harsh measure to the record rooms, and yet, after remaining exposed to the elements—in circumstances in which care for paper would have been a somewhat cynical disregard for humanity—there are heaps of precious historical records which have passed through the ordeal unobliterated. Will our feebly printed flimsy typewritten papers compete in antiquity with the brave paper and virile ink of the eighteenth century?

The difficulty of dealing with these old manuscripts on account of their decay is often surpassed by the difficulties created by the well-intentioned attempts to copy perishing records, or to arrange the whole series in classified order. When copying has had to be done, the work has usually been assigned to native clerks, and the evil is not that they have been careless, but that they have tried to do their work too well. When the native copyist is in difficulty about the spelling of a word, he invariably gives a word he does happen to know, instead of the spelling which puzzles him. The compositor of the Clarendon Press tries to set up in type what the author actually wrote; the Bengali's preoccupation is to set up what he thinks his European employer must have intended. Then as to classification. It is the very endeavour to be excellent which has produced the most perplexing results. Where the editing Collector has ordered a strict adherence to chronology, the work of dealing with his records is fairly easy; but where he has ordered his *duftri*, or binding clerk, to sort the letters and bind them under separate headings, the result is simply lamentable. In some districts one finds that the letters have been bound together in order of date; in others there is an attempt to classify them; and in no case that I know of has the principle of the classification been consistently adhered to. Suppose, for instance, the editing Collector has endeavoured to keep all letters relative to sericulture in a volume labelled "Commercial," you will probably find that the most important letter on mulberry trees has been bound up in correspondence with the Board of Revenue on matters of land revenue. There is only one way, in my opinion, of obviating

* This copy-book was made in the early part of the nineteenth century, by order of the then Collector, Mr. E. J. Barwell, son of the famous colleague of Warren Hastings. Richmond Thackeray, father of the novelist, was acting judge at Midnapur in 1811.

† As an example of this I may mention that in 1906 I discovered the long lost MS. of Father Anthony Monserrate's (S.J.) "Mongolicae Legationis Commentarius" in a heap of decayed and mostly worthless books in St. Paul's Cathedral Library, Calcutta. The book was completed in January, 1591, while the author was in prison at Sana in Arabia. Its penmanship calls for the services of an expert, but the MS. itself is uninjured by age and rough treatment.

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this difficulty. The letters must be rebound and placed, as I placed the Midnapur letters, in separate covers. The work of classification should be left to the compiler of an index.

The graphic passages I have quoted from Sir William Hunter must not, however, mislead us. The greater part of the Bengal District records are not so terribly decayed, although the decay of the remaining portion has gone very far. And it must not be thought that all the papers are of intense interest. Whole volumes may contain nothing more than the minutes of elaborate inquiries into the local peculiarities of the land-measuring rod, or the petty expenses of a police-court. In dealing with records to be used as materials for history, I would plead that it is unsafe to allow any single person to distinguish between what is important and what is not important, and to print and publish what he approves of, and turn over to oblivion what he rejects. The records of which I am speaking, belong respectively to the Revenue Department of the two Bengal Governments, and it is probable that, while the professional revenue administrator would value them for the light they throw on the history of his science, the student of social and economic history would attach a value to papers which, from the narrower point of view, seem to be unworthy of preservation. Even merely covering letters have their value, because they sometimes reveal the names of ancient offices and their holders.

I have said that nearly every chief district office has its collection of historical records, but it must not be assumed that all the local records are to be found at the head district office. When one comes to examine the record rooms, one discovers almost at once that the series of volumes are not complete, and, because there are no records for certain years in the place itself, it is natural to conjecture that the missing records either have been lost or have perished. In some cases the conjecture is sound. In the early days the Collectors, or Supervisors as they were first called, appear to have regarded the records as their own personal property, and to have taken them home with them on their retirement. That remarkable person, the Hon. Robert Lindsay, for instance, left a large collection of correspondence behind him at Sylhet, but I understand from his descendant, Lord Balcarres, that the records of Lindsay's judicial work are in the possession of the family. On leaving Sylhet in 1775, William Makepeace Thackeray, the novelist's grandfather, brought away the Sylhet records of his time, and deposited them at Dacca, where, for the present at least, they are lost.* Missing volumes are often due to the fact that at different periods the Collector was in charge of two districts at one time, and either the records of the two stations have been mixed with each other, or at one station will be found volumes of correspondence which really belong to another. Let me give an instance of the difficulties created in this way.

In 1873 Mr. F. G. Glazier, a revenue official of long experience, published an historical account of the Rangpur district, based on the records preserved at Rangpur. In this treatise Mr. Glazier occasionally speaks of breaks in the records, and he seems to have thought that these breaks were due to the volumes having either perished or been removed and lost. Now one break in the local records of Rangpur would be accounted for by the fact that in 1773 the European Collectors were temporarily recalled from the districts, and six Provincial Councils of Revenue were established. Under this system the records of the Provincial Council of Dinajpur ought to supply what is wanting for Rangpur, and these, with the exception of a few stray volumes, are to be found in the Bengal Secretariat record room at Calcutta. In going through the Dinajpur records, I found numbers of papers really belonging to Rangpur, and the explanation of this was that at one time both Collectorates were under a single individual. Of Mr. Westland's oversight of early Jessore records I have written in a footnote to this paper.

Let me give another and perhaps a more striking instance. Mr. Glazier, in his treatise, only just touches upon the subject of a serious insurrection which arose in the Rangpur District as the result of the oppressive measures adopted by the Diwan—Raja Debi Sinh. Mr. Glazier must have forgotten the story of Warren Hastings's impeachment, or he would have been at pains to tell us more about the Raja and his doings. You will remember how, in his great *coup de théâtre*, the opening speech at the Hastings trial, Burke spoke of "Devi Sing, one of the most shocking monsters that ever stained the page of history." It was the

* Mr. F. Bradley Birt has recently published a life of "Sylhet Thackeray," and has shown that where the Sylhet archives fail, those of the Board of Revenue at Calcutta wil often avail. I think Mr. Bradley Birt misleads us by describing Thackeray as "Collector of Sylhet." Sylhet was entirely dependent on Dacca at the time, while the "Collectors" were dependent on Murshidabad. Mr. Bradley Birt's book is of immense interest, and is very thoroughly done.

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recitation of the cruelties committed by this supposed creature of Hastings which made Fanny Burney tremble for her hero, while the other ladies who heard Burke and witnessed his dramatic gestures, swooned; and the great orator himself "was seized with a cramp in his stomach and was disabled from going on." The Managers, as we know, refrained from placing the misdoings of "Davy Sing" in the charges, because to do so would have enabled the defendant to expose the shallow basis of their allegations. There is enough in the history of the Hastings trial to reveal the utter shamelessness of the Managers in their attempt to fasten the alleged enormities of the Raja on the Governor-General, but the records we need in order to get at the whole story of Raja Debi Sinh and the Rangpur disturbances are to be found in seven volumes of the Commission's Proceedings, and these volumes are kept, not at Rangpur, but in the Bengal Secretariat Library, while the final report, discovered by Mr. Muddiman at Dacca, is now at Shillong, where I have had it copied for inclusion in my forthcoming edition of the Rangpur records. I mention this as an instance of the way in which the local records get dispersed, and it shows how easy it is, in existing circumstances, to despair of sources of information when they are not to be found in the local record room at which we should expect to find them.

I cannot, while the subject of the Rangpur records is suggested to us, pass on without saying just a word about the great interest they possess. One of the earliest Collectors was George Bogle, the friend of Hastings, known to wider fame as the traveller to Tibet. Another is Peter Moore, the friend and patron of Richard Brinsley Sheridan, the uncle and guardian of William Makepeace Thackeray, the novelist. Moore was a hostile witness at the Hastings trial, and another Rangpur Collector, Charles Purling—the negotiator of a treaty with Cooch Behar, Chief at Dacca, and Resident at Lucknow—was heard in the great pro-Consul's favour. Rangpur was, in the eighteenth century, essentially a frontier province, and from its records we learn something of the earliest pioneers of British trade on the waters of the mysterious Brahmaputra. We find Hastings writing in trepidation to have one George Lear prevented from "waging war in Assam"; and at one time we find the whole trade with Assam granted as a private monopoly to a Mr. David Killican. The records often touch very closely on the personal life and occupations of the writers—their fevers, their gardens, their homes, the little presents of wild animals, joints of meat, and bottles of Madeira. We hear of immense undertakings to tie down the erratic rivers to orthodox courses, and curious stories about the tricks of native merchants to turn the currency of coin in their favour. Perhaps the most interesting feature of all are the fine attempts recorded on the part of the Company's commercial agents to protect their weavers from the rapacity of the native subordinate revenue officers. The Rangpur and Dinajpur archives contain letters from Charles Grant (the father of Lord Glenelg and Sir R. Grant), to whose wise and enlightened philanthropy Bengal owes so much; from G. Udney, the protector of the great Dr. Carey; or from Creighton, the "discoverer of Gaur."

I must now pass on to discuss in general terms the essential value of these District Records as materials for history. I am afraid I have a very ill-sounding doctrine to deliver, and it is this: The history of revenue administration is the backbone of the history of Bengal under English rule. It seems to me absolutely impossible to construct the history of the English in Bengal unless you realise this plain but unwelcome truth. Neither Plassey nor Buxar was fought to win territorial sovereignty for the East India Company or for the British Crown. Our battles in Bengal were fought in order to maintain on the Musnud of Murshidabad a ruler powerless to uproot the English factories, and, as the presence of an army was continually necessary to keep on the throne the kind of ruler required to secure the commercial interests of the English Company, it became desirable that the military force behind the Nawab should be a British one. To maintain this army the English were granted land revenue, and it was essentially as revenue collectors that the English entered into the real occupation of rural Bengal. In 1765 the grant of the Diwani was made to the Company, and although when informed of this acquisition the Court of Directors endeavoured to limit their new possession to the bare receipt of the revenue, yet, as many indeed saw at the time, the Diwani, in the hands of those who had the military supremacy, was bound to absorb the Nizamat from which it was, in theory, separated. I am not going to discuss the ancient question, "Is the State the owner of all the land in India?" It is enough to say that that once much-debated question turns on a mistaken application of Western ideas of ownership to an Eastern world; but that such a question would have been

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answered in the affirmative by Verelst * certainly, and Hastings most probably, in itself shows how prevalent land revenue administration must be in the pages of a really authentic history of Bengal under British rule.

Lord Macaulay has said in his Essay on Warren Hastings, that up to 1772 "the only branch of politics about which the English functionaries busied themselves was negotiation with the native princes. The police, the administration of justice, the maintenance of order, were left to this high functionary"—*i.e.*, the Naib Diwan at Murshidabad. Mr. Westland, in his work on Jessore, goes further, and says: "I am aware that direct government is usually dated from 1772, but what the British did before 1781 can hardly be dignified by the name of internal administration." I fancy the view expressed by Macaulay represents received opinion, but I cannot conceive that it can be reconciled with the state of things revealed by the District Records.

The idea that before 1772 the English had little or no concern with revenue affairs is, I think, due to the fact that it is so often ignored that the revenue of the important districts of Burdwan, Midnapur, and Chittagong, came to the hands of the English by treaty with Mir Kasim in September, 1760, five years before the grant of the Diwani. These districts are known as the "Ceded lands," in distinction to the "Diwani portion," or remaining portion of Bengal, the revenues of which came to the Company on certain conditions in 1765. In 1765 the revenue yielded by the Ceded lands, together with the Calcutta lands, amounted to about £593,717, and that of the Diwani portion to about £1,088,718; so it cannot be thought that the revenue of the ceded districts was a matter of so little importance that it may be regarded as a negligible quantity. Let us for a moment glance at what the District Records have to reveal on the subject of the Ceded lands.

Burdwan has no local records, at least not at Burdwan itself, prior to 1786, but a good deal of the history of the district between 1760 and 1772 may be gathered from Verelst's "View of the Rise, Progress, and State of the English Government in Bengal" (1772), and from the reports of the Parliamentary Committee in 1773. Midnapur has records from 1764 onwards. The Chittagong records commence with the arrival of an English Chief and Council in 1760, but there are lengthy breaks in the series, volumes having been reported as lost in the time of Warren Hastings's governorship. Now, the records of Midnapur and Chittagong show that from the very first the English assumed the direct management of the revenues, and with this went the administration of civil justice and the police control of the country. Burdwan, from 1760 onwards, received very special attention.

It must also be recalled to memory that from November, 1698, the Company had been zamindar or talukdar of the three towns which form the nucleus of modern Calcutta. In 1757 the Company became zamindars of the important district known as the Twenty-four Parganas, which in the year May, 1758—April, 1759, realised in revenue £57,996, rising in 1760-1 to £110,418. I have not time to show you that, although the method of raising the revenue usually adopted was to farm it out to speculators, the Company's servants, as a matter of fact, had not only obtained, before 1772, a very considerable acquaintance with revenue affairs, but had intervened with marked results in the police of the country, and in the important Ceded lands and Calcutta lands had taken nearly every step to realising territorial sovereignty, save that of reforming an iniquitous administration of criminal justice. It was in the matter of judicature in criminal cases that English energy held fire, and even in this respect I believe that our ancestors in Bengal did far more in the direction of humane method during this difficult period of confused theory than the theory on which their occupation was based could justify. In a brief paper, as the present must be, I cannot hope to marshal even a third of the arguments which these old records afford, to destroy that pernicious view of the origin of the English Empire in India which Macaulay's genius has popularised in prose, and of which Rudyard Kipling is poet laureate:—

"Once, two hundred years ago, the trader came,
 Meek and tame.
Where his timid foot first halted, there he stayed,
 Till mere trade
Grew to Empire; and he sent his armies forth
 South and north;
Till the country, from Peshawar to Ceylon,
 Was his own."*

* "The lands were the property of the Crown and were annually let to zamindars."—Verelst, "View," p. 65.

* "A Tale of Two Cities," in *Departmental Ditties*. The late Dr. Wilson has well said: "If the common opinion about these matters were true, if old Fort William was the work of thoughtless, worthless adventurers, and the Indian Empire the outcome of chance and accident, I, for my part, do not see how such views can be reconciled with scientific theories of history, much less with a belief in an over-ruling Providence rewarding men according to their works. But the truth is far otherwise. There can be no greater mistake than to suppose that the English settlement at Calcutta was

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Mere trade was never good trade, and *mere* trade never led to empire. The growth of a rural administration is the secret of the expansion of English influence in Bengal; and it is of this growth, despite blunders, despite personal wrong-doing in all directions, despite unintelligent criticism of self-seeking advocates at home, these old records—sometimes like the writing of Mr. Sims, of Calcutta :—

"And a very pleasant running hand good Mr. Sims did write,
His up-strokes were like gossamer, his down-strokes black as night,
And his lines all clear and sparkling, like a rivulet in May,
Meandered o'er the folios—alas, and well-a-day!"

and sometimes "chips of paper mingled with the granular dust that white ants leave behind,"—tell the tale.

The old District Records of Midnapur and Chittagong, then, take us back to the earliest attempts of the Company's servants to establish an internal administration in Bengal. For Chittagong we have, of course, an excellent account of the records in Sir H. J. S. Cotton's "Memorandum on the Revenue History of Chittagong," published thirty-one years ago, and now exceedingly difficult to procure. I am glad to be able to report that, before leaving India, I supervised the work of haivng the Chittagong records copied, and their printed publication will, I believe, follow on my return from furlough. The Midnapur records, as I have already stated, were copied almost entirely by myself, as the work of deciphering them frequently required an experienced eye. I will say something later on about the work achieved in connection with the districts of Sylhet, Dinajpur, and Rangpur, which belong to the Diwani portion of Bengal, and relate to an early history of a different character from that of the Ceded lands.

When in 1765 Lord Clive secured the Diwani for Bengal, the Council at Calcutta determined that they would not enter at once into the direct administration of their newly-acquired revenues. Verelst, in the work I have referred to, tells us that the Council "very wisely determined to assume the slow but certain conviction of experience for their guide, giving their first attention to these provinces, the revenues of which had been subject to the administration of Europeans from the first cession of these lands by Mir Kasim in 1760. The event corresponded to their views. In the year 1769 the condition of these last-mentioned provinces formed so striking a contrast to the other parts of Bengal, where the oppression of ancient government was universally felt, that foreigners as well as natives began earnestly to wish for a more extensive reformation." * The Ceded and Calcutta lands were thus the hard school in which the Company's servants gained a valuable experience in the work of internal administration ; and in 1769, when Verelst was himself Governor, the authorities at Calcutta, "taking advantage of an equivocal permission in a letter from the Court of Directors, sent forth English Supervisors to take stock of, and, by strong moral pressure, improve the course of justice, criminal as well as civil, render the collection of the land revenue as little oppressive to the ryots, and to inquire into and report upon the history of their respective districts since the time of Suzah Cawn, as, at that era of good order and good government, no alterations had taken place in the ancient divisions of the country, and the confusion which is now apparent has been posterior to those times."† These Supervisors, as we know, ultimately became Collectors. For no good reason this institution of Verelst's has been derided. Had the reports of the Supervisors been before the eyes of our historians, I cannot help thinking that they would not have so rashly followed Kaye in scoffing at a measure which was exceedingly fruitful in new stores of information, and which effected some marked improvements in the conditions of the people. For what was done by these early European agents of the Company in the lands of the Diwani portion, we need to have to hand the records of the Resident at the Durbar.‡ I have only been able to see portions of these records, but what I have seen enables me to speak with confidence as to their great historical value.

fortuitous and ill-considered. Nothing can be further from the facts than the generally accepted picture of 'the mid-day halt of Charnock,' growing to be a city, 'chance-directed, chance-erected,' spreading chaotic like the fungus. Had the English confined themselves to 'mere trade,' had the merchant remained 'meek and tame, where his timid foot first halted,' there would have been no Calcutta and no British India."—"Bengal : Past and Present," Vol. I. p. 30.

* Verelst, "View," p. 75.

† *Ibid.*, p. 230.

‡ The Comptrolling Council of Murshidabad, constituted by the letter of July 13th, 1770, from the President and Council of Fort William, created a new jurisdiction to take the place of the Resident at the Durbar. Becher, who had been filling the office of Resident, became chief of the Comptrolling Council. The records of the Resident at the Durbar are, according to Mr. A. P. Muddiman, to be found at the Bengal Secretariat, but a "tattered and mutilated' letter copy-book of the Supervisors of Nattor, commencing December 30th, 1769, is preserved at the Nizamat record room at Berhampur. The Comptrolling Council of Murshidabad sat for the last time in September, 1772, and its records are now at the Bengal Secretariat in Calcutta. After its

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Luke Scrafton, and, immediately following him, Warren Hastings, had held the office of Resident at the Durbar, but apparently the office as originally formed came to an end when Hastings was brought down in 1761 to take his place as a member at the Council Board of Fort William. In 1765, after the grant of the Diwani, Mr. Francis Sykes (afterwards a baronet) was sent to Murshidabad to take up the post of Resident on a new and magnificent scale. In addition to his fixed salary as a Company's servant, I find that in less than two years he received £35,757 18*s.* as his share of the commission allowed on the revenues—about £6,200 from the Malkaut or additional cesses, and close on £2,000 in complementary donations at the time of the Punya. In addition to this he had a sumptuary allowance amounting to about £4,450 a year. It need hardly be said that Mr. Sykes had a private business of his own. The Resident from the very first supervised the work of the Naib Diwan, who Macaulay seems to think was absolutely uncontrolled; and on at least one day in each week the Resident inspected the courts at Murshidabad—a place which I may, perhaps, remind you was, until the time of Lord Cornwallis, spoken of as "the City," in distinction to Calcutta, which was called "the Presidency."

Sykes was succeeded in 1769 by Richard Becher—a person with an exceedingly pathetic history, of which Dr. Busteed has written in "Echoes from Old Calcutta," and Sir William Hunter in his "Thackerays in India." It was with Becher, as Resident, that the Supervisors corresponded. Becher's personality is strikingly exhibited in the history of the great famine of 1770. Hunter speaks of him as the one Englishman who really made a resolute attempt to meet the exigencies of that terrible situation. I fancy that Hunter, in casting blame on Cartier's government at Calcutta, did not realise that Becher was practically the responsible person, and I do not think that Hunter had before him sufficient evidence on which to form an opinion. Until we have achieved more in the direction of the printing of the District Records I feel certain our judgment cannot be adequately confirmed, and it is no small evil that the withholding of historical materials renders it possible for any disloyal and irresponsible scribbler to compile "economic histories" which are economic only in the sense that they emit the truth in scanty rays. A curious instance, on the other hand, of the way in which officials have been compelled to rely on the happy-go-lucky researches of chance record-hunters, is afforded by James Grant's "Analysis of the Finances of Bengal," which was compiled from public records which had fallen into private hands, and purchased by Grant for his personal edification.*

It need hardly be said that these records throw a full light on the condition of the Province at the time our first administrators entered it. The further research goes back in the past the more remote seems to be that golden age which modern unrestful persons depict in their speeches to men in the street. The utter anarchy, the completeness of the breakdown of Moghul order (if such a thing ever existed), the vast hordes of armed Hindu mendicants, the organisation of open murders and pillage by ancestral dakoits, the rack-renting of the cultivators, the connivance of the landowners (with whom lay the police), are not to be met with occasionally, but form a constant feature in the picture.

I have attempted to challenge the prevalent view taken by historians—notably by Macaulay—that until the Court of Directors in 1771 sent out their famous decision "to stand forth as Diwan," the servants of the Company had done nothing in the way of rural government. It has been shown that in the important districts of Burdwan, Midnapur, and Chittagong, and also in the Twenty-four Parganas, the Company managed its revenues from the first, and that even in the Diwani portion the transactions of the native official at Burdwan were supervised by the English Resident at the Durbar. In regard to the administration of civil justice in Calcutta and in the Twenty-four Parganas the Company was itself the zamindar, and held the customary zamindary courts. In the Ceded lands the Company attempted "to maintain the forms of the ancient country judicatures, and at the same time correct many abuses." In the Diwani portion the Supervisors in 1769 were directed "to make strict and speedy inquiry into the proceedings of the courts of justice throughout their settlements, and that if any extraordinary powers have interfered to interrupt the

dissolution, the Resident of the Durbar (Samuel Middleton) occupied his old position in revenue affairs, and his records are in the Nizamat record room of the Murshidabad Collectorate. In February, 1775, Edward Baber, the then Resident, became chief of the Provincial Council of Murshidabad, and the office of Resident became purely political. The records of the Provincial Councils (instituted November, 1773) are widely scattered. Those of the Calcutta Provincial Council, which, after May 12th, 1780, assembled at Hughli, would illustrate the partisan divisions of subordinate bodies created by the great opposition of Francis at the Council itself.

* About two years ago I noticed some fragments of the old Factory Records of India quoted for sale in a secondhand bookseller's catalogue; the price asked was high, as an autograph letter from Lord Clive was included.

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course and administration of justice, they should, without delay, correct all such abuses." When the Court of Directors were first informed of the acceptance of the Diwani by their Governor in Bengal, they wrote out: "The administration of justice, the appointment of officers, zamindaries—in short, whatever comes under the head of civil administration, we understand remain in the hands of the Nabob and his ministers." This was an error, for the civil courts, both at the capital and in the district (Sudder and Mofussil Diwani Adalat) were constitutionally part of the Diwani. In March, 1768, the Court of Directors went so far in the other direction as to recommend the Select Committee to endeavour to introduce a law of inheritance, "as near as possible to the laws of this country," to abolish the power of seizing the effects of persons dying without children, and to introduce the right of bequeathing by will. It would seem that Sykes was successful in getting some very necessary new judicatures established at Murshidabad, and we find the Supervisor of Nattor, March 4th, 1771, abolishing a petty criminal court, which he calls the Bazy-Jumma, while the Supervisor of Dinajpur divides his district into divisions, creates courts, and selects the judges. In April, 1771, the Court of Directors sent out recommendations of various reforms in the courts, and at the end of the year the Council at Fort William wrote to head officers or councils of the various districts to give effect to these recommendations. From Midnapur, as we should have expected, the Resident writes in reply that the recommendations so far as his district was concerned were needless: "All the judicature in that district was exercised under the authority of the Resident and persons appointed by him in every Pargana; that all cases in inferior districts were reported to the Resident, and every case duly registered in the Phousdar's cutcherry, so that there were no arbitrary fines or impositions, or any undue authority exercised, independent of the Resident."

With regard to the administration of criminal justice, there is much truth in Lord Macaulay's observation. For this administration belonged to the Nizamat, and not to the Diwani with which the Company had been invested. The apprehension of criminals was, indeed, an ordinary duty of the zamindar, but their trial belonged to the Faujdar appointed by the Nawab. For the punishment of crimes of a serious nature it would seem that the sentences were sent down from the Nizamat authorities at Murshidabad. The Chittagong records, in particular, throw a lurid light on the nature of these sentences. Here, for instance, is a list of penalties ordered by the Nizamat. The list is dated November 18th, 1773, and provides for eight dakoits to be confined in chains for three years; five dakoits who had committed murder to suffer death; nine housebreakers each to receive fifty strokes of the korah; a case of manslaughter to be punished by fine, and two men to have "their right hand and left foot cut off." The Chief of Chittagong, on his own authority, suspended the execution of the sentence of mutilation, but on July 11th, 1774, the Governor (Warren Hastings) writes: "The officers of the Nizamat Adalat have again declared the propriety of the sentence, and that it is strictly conformable to Mohammedan law. As the natives are not to be tried by our notions of justice, but by the established law of the country (excepting in very extraordinary cases, where it has been usual for Government to interfere), I must request that you will permit the officers appointed for the purpose to carry the warrants into immediate execution." The same records, on three or four occasions, give instances of the terrible infliction of death by impalement. The Collector of Behar, as late as December 24th, 1789, writes in an official report: "I hope that humanity will not be shocked by staked spectacles writhing in agony, if superior judgment shall resolve that partial torture does not promote general security."

The District Records supply some exceedingly strange instances of Mohammedan criminal law. Murder, being viewed rather as an offence against a particular family than against society, could be pardoned by the murdered man's heir; and as the heir would be in terror of incurring the anger of the criminal's kindred or of infuriating the judge by rejecting his intercessions, he would, to borrow the language of the records, "be glad to relinquish a painful privilege which involves timid minds in a delicate embarrassment." The choice of the weapon used to kill would decide whether or no the killing constituted an act of wilful murder or not; to kill with a sword or a knife would admit of the worst construction, but to hold the head of a child under water until death ensued would not of necessity be intentional murder. An accepted comment on the Koran, to the Collector's indignation, led to the mitigation of the sentence of death pronounced on a man who had in a very brutal manner murdered his child. The

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commentator had ruled that the death of an adult was more than equivalent for the destruction of a child.

From what has been said it will be seen that the value of these old Bengal District Records lies in this, that they are the most important evidence we have in order to enable us to construct the history of the really effective occupation of the country by English administrators or supervisors. Our ordinary history books tell us much of the battles and the treaties by which the Company secured its military supremacy, or its legal titles, but the essential duty of the historian is not so much to record the acquisition of titles by force of arms or treaty, as to trace the actual advent of English influences over the lives of the inhabitants of the country. Various authorities have discussed the question when was territorial sovereignty in India acquired, but this, like the famous question "is the State the landowner in India ?" is a matter which entirely depends on the meaning we assign to certain abstractions. When the student begins to study Indian history at all seriously, the first thing he must do is to unlearn what he has been taught in his school books: "1757. Calcutta retaken. The battle of Plassey (June 23rd) secures Bengal for England." * It is disappointing, to say the least of it, to find that the "Cambridge Modern History" (Vol. VIII.), simply scamps the task of telling us how the English entered into touch with the millions whose increasing happiness is the sole justification for all that England has spent in India by the lifelong exile or early death of her sons, the sufferings of hundreds of English women and children, and the loss of things for which an income in excess of that which may be ordinarily earned by industry at home, or an assured pension, are in no sense equivalents. To these old records we must turn if we wish to recover the story of the real influence of English government on the people, the authentic motives and actual results of English administration.

In 1782 Philip Francis, after his return from India, declared, "Under a European Government Bengal cannot flourish," and pleaded that, "Europeans in Bengal should be limited to as small a number as the services of the Government will admit of."† The existence of the great European merchant houses of Calcutta and Bombay affords a sufficient comment on Sir Philip's words about the European in India not in Government service: "Exclusive of public employment, or contracts with the India Company, there is no occupation for the industry of Europeans in Bengal. Every enterprise they engage in, whether of foreign commerce or internal improvement, leads them into distress, if it does not end in their ruin." Exceedingly interesting results would be obtained if the records of the various factories could be recovered and placed under contribution. I understand that some at least of the proceedings of the now long defunct Board of Trade are to be found in the record room of the Board of Revenue at Calcutta. The rural records, which I have been dealing with exclusively, do, as a matter of fact, throw some light on the commencement of private European industrial undertakings—the growth of the indigo plantations, for instance.

There is one very important point to be remembered in connection with these records—and indeed all records which are to be used as materials for history. The writers often, if not always, write in order to put on record what is likely to be unknown or easily forgotten, and a knowledge of all that was widely known and easily remembered is taken for granted. Thus a great event, because it created a stir, and was a matter of knowledge to superiors at headquarters, may be only just alluded to, or a few of its circumstances or consequences detailed, in the daily correspondence, while a hundred and one matters of very minor importance are treated with tedious amplitude. It is quite characteristic, for instance, that the Court Chronicler of the Manipur Raj, tells us very little about the taking of Manipur by the English ; while he does record the days on which the guilty persons were hung. The capture of the place, just because it was the supreme event, escapes with but small notice. So it is with the great famine of 1770 in the English rural records. The references to it are surprisingly scanty, and on the principles of a certain kind of criticism with which we have been troubled far too much, it would be necessary to adopt a tone of enlightened scepticism about the famine ! As a matter of fact, it is the very silence of the records, in these and like cases, which is so eloquent.

If I had time to deal with the element of personal interest, I should take my illustration from the career of the Hon. Robert Lindsay, as disclosed by the Sylhet records. I should tell you the story of how that remarkable man, while

* Acland and Ransome, "English Political History," p. 138.

† Francis, "Original Minutes." Introduction. The word "Government" in the usage of Anglo-Indians of this time usually denoted, not the Company, but the Nizamat. Barwell usually speaks of the Company in its governmental capacity as "the Publick."

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ruling one of the most turbulent frontier districts with conspicuous ability and success, controlled by personal influence the wild tribes on the Khasi border, and built up for himself a noble fortune by the industries of which even shipbuilding, at his far-inland station, was one. I should tell you how, to meet a famine, Lindsay exported rice to Madras in ships of his own building, and how, by a happy bid with the Government at Calcutta, he obtained control of the cowries in which the revenue was transmitted, and so secured almost a monopoly of the famous Sylhet lime. And if it had been my good fortune to have studied the records preserved at the remote little station of Dumka, I should, had the time been mine, been unable to resist the temptation of describing to you the ever-memorable work of Cleveland amidst his half-savage hillsmen. I should have been tempted to travel beyond the limit of my own special period, and from the records at stations on the Brahmaputra tell you of one who, if he had in the Punjab performed the things he did on the too-little regarded North-East Frontier, would have engraved his name in the temple of fame side by side with the Lawrences. I refer to David Scott, whose memory has not lost its magic in Assam, and whose lofty monument looks down from the rain-beaten crags of Cherra Punji, over the dreamy plains of the valley of the Surma.

An apology is no doubt due for the occasional references I have had to make to my own work, and I have more than hinted that a date is set as a limit to my researches. That date is the date of the permanent settlement of Bengal and Lord Cornwallis's reforms. To have travelled down nearer to our own time would have necessitated a stern refusal to take a wide survey. Several valuable treatises have been compiled on the records of various stations whose names I have mentioned. We have, for instance, Cotton on Chittagong, Field on Midnapur, Glazier on Rangpur, Beveridge on Bakarganj, Westland on Jessore, Hand on Behar; but, with all humility, I venture to say that the value of these books has to some extent been impaired by their several authors having restricted their attention too strictly to the records preserved in their own particular record rooms.* It is for this reason I have preferred to limit my period, and to utilise the time saved for the study of more than one series of local records at one time. While reading the official records, I have derived much assistance from the perusal of the private letter-copybooks of Richard Barwell, which are now the property of the almost defunct Calcutta Historical Society.

In speaking of works already in print, Sir W. Hunter's four volumes of "Bengal MSS." should not be forgotten.* Useful as these volumes are, they do not give us the letters *in extenso*, but in provokingly brief *précis*. Sir W. Hunter makes selections only from the records preserved at the offices of the Bengal Board of Revenue in Calcutta. In the "Rural Annals" the records of only a few districts came under survey, and Sir William can only be said to have made a very partial use of these. Mr. E. G. Drake Brockman, in a far too scantily printed pamphlet, has shown that the first harvest of the "Rural Annals" in these comparatively obscure districts, has left the greater part of the fields unreaped.

The reading of this paper affords a natural occasion of expressing my gratitude to those who have indulged me with the opportunity of making what have been to me the most delightful leisure-time studies. By the courtesy of the Government of India I have been enabled to collect together a series of documents relative to the French Settlement of Chandarnagore during the time of the war between France and England. These documents have nearly all appeared, in a rather unclassified array, in various numbers of "Bengal: Past and Present," and thanks to my co-adjutors the origin of this isolated dependency of France has now been set in a clear light. For many suggestions, and the loan of a valuable report, I am indebted to Mr. A. P. Muddiman, I.C.S. To the Government of Bengal I am indebted for a lengthy loan of all the early Midnapur records. Mr. R. J. Hirst also worked out for "Bengal: Past and Present" (Vol. VI.) a description of the Burdwan records from 1786 to 1790. To Mr. J. Rankin, I.C.S., I am indebted for the sight of copies of old

* An illustration is afforded by Mr. Westland's assertion that not till 1781 did the English attempt anything of the nature of real internal administration. The records of Jessore, as actually found at that place, might bear this out, and it is on these locally-preserved records that Mr. Westland's book is based. Westland, therefore, commences his survey of the English activities in Jessore with the correspondence of Mr. Henckell, appointed judge and magistrate in 1781; and Mr. Westland clearly had no knowledge of the correspondence of Robert Wilmot, Supervisor of Jessore in 1769, and the evidence relating to the history of the district to be found in the correspondence of the Resident at the Durbar and in the proceedings of the Murshidabad Comptrolling Council of Revenue.

* Long's "Selections from the Unpublished Records" do not require notice here, as we have district records only under consideration; but Mr. Long's volume amply illustrates the unwisdom of publishing records in selections only.

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Dacca papers. To the Government of Eastern Bengal and Assam I am most deeply indebted, not only for defraying the expense of journeys to Sylhet and Rangpur, and for the loan of records from both those places and Dinajpur into the bargain, but for their kind consent to have these records printed at the Secretariat Press. The kindness of Sir Lancelot Hare, the recently retired Lieutenant-Governor of Eastern Bengal and Assam, and that of three chief secretaries in succession—Mr. Lyon, Mr. Nathan and Mr. Beatson Bell—has been the greatest encouragement to me to go on with the work with a zeal unimpaired by the difficulties inseparable from an undertaking so intricate and so lengthy.

APPENDIX I.

EXPLANATION OF SOME TERMS EMPLOYED IN MR. FIRMINGER'S PAPER.

Diwani and Nizamat. The prince (Nawab) who occupied the *musnud* (throne) at Murshidabad, was Viceroy of the Emperor of Delhi, and was usually described as the Subahdar of Bengal, Behar, and Orissa, although the greater part of the last-named place had been seized by the Mahrattas and was ruled by them from Cuttack. As commander of the imperial forces, the Nawab lost all military power by the Emperor's *farman* (grant or charter) of August 12th, 1765, which placed the military defence of the Province in the hands of the Company, and by the treaty with the Nawab Nadjam-ud-Daulah, February 25th, 1765, which limited the troops maintained by the Nawab to the support of his personal dignity. As *Nazim* the Nawab was the chief officer charged with the administration of the criminal law (*i.e.*, that of the *Koran*) and the olice; as *Diwan* he was charged with the administration of the civil law and the collection of the revenues. The idea of separating these two offices, and conferring the second on the Company seems to have originated with the Emperor Shah Alam, and was the subject of a proposal made by him to either Eyre Coote or Carnac in 1761. The grant of the *Diwani* (office of the Diwan), August 12th, 1765, coupled with the right to exercise military power, left the Nizamat alone to the Nawab, but the English at the time, and long after, held that the executive power was centred in the *Nazim* or holder of the Nizamat. On his retirement from office, Governor Verelst, December 16th, 1769, warned his successor, John Cartier: "We have reached that supreme line, which to pass would be an open avowal of sovereignty. It should be remembered that we cannot be more, without being greater than sound policy allows; the interests of our employers at home, no less than our national connections abroad, forbid it . . . Every order should scrupulously wear the sanction of the native Government."—Verelst, "View," p. 123. It was this constant dread of awakening the jealousy of European Powers which dictated the delay of the Company in realising what the grant of the collection of the revenues, the exercise of military power, and the supervision of civil justice involved. Verelst himself seems to have seen that the protection of the people who paid the revenues was bound to lead to the ending of a state of divided power, in which the native hardly knew to whom he was to yield obedience. In the same letter he writes: "Paradoxes are not to be reconciled, highly injurious to our national character, dangerous to the best defended establishment, and absolutely bordering on inhumanity." In 1775, Francis, Clavering, and Monson attempted to stay the trial of the Fowkes, Nuncomar, and Rada Chun, by claiming for the last-named an exemption from jurisdiction on the ground that, as Vakil to the Nawab, he held the privileged position of an ambassador from a sovereign power. The judges did not feel themselves bound to pronounce on the subject of the sovereign power claimed for the Nawab, but dismissed the objection on other grounds. In 1772 the Supreme Criminal Court (Nizamat Adalat) was brought down to Calcutta, and placed under the charge of a Darogha (Superintendent), subject to the control of the President of the Council, who revised the sentences of the criminal courts in capital cases. In October, 1775, the Nizamat Adalat was sent back to "the City" (Murshidabad) and placed under the Naib Nazim (deputy to the Nazim). Some material changes were effected in 1781, but in 1790 Lord Cornwallis's regulations effaced the last vestiges of the authority of the Nawab as Nazim.

Faujdar (fauj = an army, dar = one who holds or owns; corruptly, "phousdar"). Originally a military official, but in the early English period the chief Mohammedan executive officer of a district in all matters connected with the peace of the district.

Zamindar (zamin = land). Whether the zamindar really owned the land or was merely the State-appointed collector of the revenue from a given area or areas, is a much discussed question. The terms of the sanads (or patents) conferring the position required the zamindar not only to collect duly and render in the land revenue, but also to maintain the roads in good order, to apprehend thiefs and robbers, and send them for trial, to protect travellers, and to suppress drunkenness. The land revenue represents the ancient right of Government to a share in the harvest reaped by the cultivators. It is frequently, but misleadingly, spoken of as "rent," and also as a "land tax."

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APPENDIX II.

DATES OF PRINCIPAL ALTERATIONS IN REVENUE ADMINISTRATION.

1633. Factories at Balasore and Hariharapur founded by Cartwright, seemingly on the authority of a charter (*farman*) from the Emperor Shah Jehan.

1650. Possible activities of Surgeon Gabriel Boughton in obtaining trade privileges for the English.

1651. Bridgeman and Stephens found a factory at Hughli. In the years following factories established at Patna, Cossimbazar, Dacca, Malda, etc.

1686. December 20th. Job Charnock abandons Hughli.

1690. August 24th. Charnock's "Mid-day halt." The birthday of modern Calcutta.

1698. Azim-us-Shan, grandson of Aurangzeb, gives permission for the purchase from the native zamindar of the talukdari rights of Calcutta, Sutanuti, and Gobindpur, subject to an annual payment of 1,195 rupees.

1699. Ralph Sheldon becomes the first Collector of Calcutta.

1714–17. The Surman Embassy to the Court of the Emperor Farokhsir, who grants the English permission to purchase the talukdari right of thirty-eight villages adjacent to Calcutta. The Nawab, Murshed Kuli Khan, prevents the purchase.

1756. June 21st. The tragedy of the "Black Hole."

1757. January 2nd. Clive and Watson recapture Calcutta. (Justice Hyde, Justice Chambers consenting, in the case of Bakshi Ali: "We say the inhabitants of this town are all British subjects, because this town was conquered by Admiral Watson and Colonel Clive, but that does not extend to subordinate factories."—Morton, *Decisions*, p. 103.)

1757. February 9th. Treaty with Suraj-ud-Daulah. The zamindars permitted to sell according to Farokhsir's *farman*.

1757. June 23rd. Plassey. Mir Jafar agrees to grant to the Company the land within the Mahratta Ditch and 600 yards without, and the lands south of Calcutta as far as Kalpi, on payment of a quit-rent. Origin of the Twenty-four Parganas.

1759. Mahomed Ali Gohur (afterwards Emperor Shah Alam) invades Behar. Mir Jafar, alarmed by the idea of Clive supporting the Prince, grants Clive, as a token of gratitude, as *jagir* or assignment, the rent of the Twenty-four Parganas. By an imperial *farman*, June 23rd, 1765, this jagir was confirmed to Clive for ten years, from May 10th, 1764, after the lapse of which term or Clive's death, the jagir was to revert to the Company as an unconditional gift.

1760. September 27th. Treaty with Mir Cosim (Mir Kasim). The revenue of Burdwan, Midnapur, and Chittagong assigned to the Company to defray the charges of their army. (The Burdwan revenues had been temporarily assigned for that purpose at an earlier date.)

1763. July. Mir Jafar, on his restitution, confirms the cession of Burdwan, etc., etc.

1765. January. Mir Jafar dies.

1765. February 25th. Treaty with Nadjam-ud-Daulah, who confirms all previous grants, and undertakes to maintain troops solely sufficient in number for the preservation of his personal dignity.

1765. August 12th. The Emperor grants the Diwani to the Company.

1769. Appointment of English Supervisors throughout the Diwani portion.

1770. The Court of Directors, letter dated March 23rd, 1770, order a Controlling Committee of Revenue to be formed consisting of four members, to whom the entire management of the revenues is to be entrusted.

1770. July. The President and Council constitute Controlling Councils of Revenue at Murshidabad and Patna.

1771. The Comptrolling Committee, as ordered by the Court of Directors, formed, and sits for the first time on April 1st.

1771. August 28th. The Court of Directors write the letter in which they express the determination to stand forth as Diwan, and "take upon themselves entire care and management of the revenues by the agency of the Company's servants."

1772. April 13th. Hastings assumes the post of Governor.

The Committee of Circuit makes a five years' settlement by farming the collections to the highest bidder. The Khalsa ("Exchequer") brought from Murshidabad to Calcutta. The Supervisors renamed Collectors.

Regulations for the administration of justice.

1773. November 23rd. Upon the arrival of orders from the Court of Directors, the system of 1772 has to be revised, and a plan, part intended to be permanent, and a part temporary only, is adopted.

a. Permanent.

1. Native diwans or aumils to be appointed to each district, except such as have been let to zamindars or responsible farmers.

2. A Committee of Revenue formed at the Presidency, consisting of two members of the Board, and three senior servants below Council.*

* Mr. Muddiman writes: "Of the five Provincial Councils constituted by this change, the Calcutta Committee of Revenue is the one which has caused so much confusion in the Secretariat and Board's record rooms. It will be observed that this body was in no way the supreme record authority, which remained, as before, the Revenue Board consisting of the whole Council, but merely a co-ordinate authority with the other five established. It has been, as a rule, confused with the Committee of Revenue, which replaced the Provincial Councils for the whole country in 1781."

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3. Commissioners to be appointed for purpose of inquiry as occasion occurs.

β. Temporary. Bengal and Behar divided into six Provincial Councils (Murshidabad, Burdwan, Dinajpur, Dacca, Calcutta, and Patna)* each composed of a chief and four senior servants.

The Collectors to be withdrawn on finishing their current treasury, and Naibs to be appointed to hold courts of Diwani Adalat in subordinate districts, and members of the Council to hold the civil courts at their respective head stations.

1775. Great revenue debates and rival plans put forward by Hastings and Barwell conjointly on the one hand, and Philip Francis on the other. Francis opposes the Governor's proposal to institute an inquiry into the revenues, which, however, is carried. Francis advocates a permanent settlement with the zamindars.

1776. The Commission of Anderson, Croftes, and Bogle to inquire and report on the revenues.

1780. Six provincial civil judges, independent of the Revenue authorities, appointed.

1781. February. Committee of Revenue formed (by five senior servants) at the Presidency. Provincial Councils abolished. Office of Superintendent of the Khalsa Records abolished, and that of Preparer of Reports to the Board of Revenue instituted. European collectors return to the districts.

[A corrupt motive for the abolition of the Provincial Councils was imputed to Warren Hastings at his impeachment, but the records show that the Provincial Councils from the very first had been regarded as a temporary measure only.]

1786. June 1st. The Board of Revenue instituted—a junior member of the Council and five senior servants of the Company—subject to the general control of the Governor-General in Council.

In the absence of the author the paper was read by the Rev. J. A. V. Magee, M.A.

DISCUSSION.

The Chairman thought it would be agreed that the paper had been a most instructive and interesting one, for which a debt of gratitude was owing to the author. Also the Society was much obliged to Mr. Magee for coming forward to read it. One point that immediately struck him after listening to the paper was the vast amount of material that lay buried in the District Records of Bengal. In the two Bengals there were more than forty-five districts, and one could form some idea as to the amount and variety of the materials that lay hidden there. The paper gave ample testimony to the value of these materials from the historical point of view. To utilise these fully, it appeared to him that the first thing to do was to take up each district separately and to gather together all the papers that might be found of interest and importance, and then to collate them collectively in order to obtain a proper and full account of that period of the history of Bengal to which they relate. The records after all did not cover a very long time; they began some years after the Battle of Plassey, and went on to the time when Lord Cornwallis introduced the permanent settlement, and thereby practically reduced the interest in the land administration of Bengal. But the records of those years were of the greatest interest and value, owing to the fact that they covered the experiments and the trials that were made at the time to introduce order and good government out of the chaos in which the country was when the Mohammedan power broke up and the English came upon the scene. They showed how civil government was gradually evolved out of absolute disorder and confusion. In that respect the records for that short period of twenty-five years were of the greatest value, and he thought they were of greater importance than any records that could be found elsewhere in India in connection with the early period of British history. He hoped that the records would not be left to be dealt with by individual enthusiasts, as had been hitherto the case, but that the work would be taken up systematically and thoroughly. If that were done, he had no doubt the historian of the future would find the material of the greatest value.

Mr. S. Charles Hill (Director of Public Instruction, C.P.) said there was one point in Mr. Firminger's very interesting paper which was of extreme importance, and which had been already referred to by the Chairman, namely, the necessity of printing the early records of Bengal in full. The author, of course, had spoken only of the records of Bengal, but he himself had had to deal with the records of the Government of India at Calcutta, and recently he had seen something of the Presidency records of Madras, and what held good of Bengal held good, he thought, of the other Presidencies. He himself had been one of the enthusiasts referred to by Sir Krishna, and had published for the Government of India a collection of papers dealing with a certain period in Bengal. He found that that involved a very unpleasant responsibility. If he excluded any paper it appeared as though he said that the paper was of no use whatever, while all the time he knew that no one could say that of any paper. No paper could be said to be useless until all the papers had been printed and studied by various students from different points of view. A paper which was useless at one time might become very useful later on, and he thought the mere enumeration of the various papers the author had given showed that a very large quantity of information was lying hidden in the District offices and in the Presidency offices of

* Behar remained under the Chief Council of Patna until the abolition of the Provincial Councils in 1781. The Chief of Chittagong (and Tippera), under the system of 1773, corresponded direct with the Board.

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India, information which was absolutely necessary to form a correct estimate of what the English had done in Bengal. It was, however, not only the past people were interested in; they were also interested in the future. Therefore, he thought the value of the records should be considered, not merely from mere sentiment for the past, but with regard to their guiding effect in the future. When the East India Company conquered India, it took over the administration of the country as the easiest way of obtaining that order and peace which were needed by the Company for its own trade, and by the people of India to recover from the chaotic condition into which they had fallen by the break-up of the Mogul Empire. It was easier for the Company to govern by Europeans than by the natives. In various cases they tried to govern through Indian officials, but, owing to one misapprehension or another, or change of policy, most of those attempts ended disastrously. So much was that the case that an idea grew up that the natives of the country could never manage things for themselves. That was an exploded idea now. Great Britain was no longer simply trying to develop the country, but desired that the people of the country should have a chance of developing things themselves. Statesmen were not concerned simply to find out what India wanted; they wished to know whether the people of India were capable of doing the work for themselves. If that was true, the first thing to be done was to know exactly what the people of India were, and what their capacities were, and also their desires and wishes; and he did not think information of that kind could be found anywhere so well as in the early records. The records were not simply statements of what the English had done in India; they were also a storehouse of the knowledge and experience of some of the best men who ever went to India, men who were keenly interested in the country, and who put on record what they had learnt by careful inquiry and experiment. Without wishing to draw any comparison, he thought that possibly those men knew India better than any men now living could know it, because they lived in an India upon which the Western mask had not yet fallen. It was for that reason he wished to see the papers published. Madras was the only Presidency that had seriously faced the task of publishing its records, but he did not think it had yet undertaken the District Records, and he believed there was no other Province in India which had systematically undertaken the complete publication of any set of records whether Presidency or District. Every effort ought to be made for systematic publication at once. A complete publication was much more feasible and much more practicable than the publication of a set of collections on different subjects. To have a set of collections of papers on different subjects would necessitate either gathering all the records in one central place, or capable men going from district to district making inquiries from extremely busy men, and the inquirer would have at the end to confess that he was not getting anything like the information he wanted. On the other hand, systematic publication of the whole of the records would give something which would last for all time, and would meet all requirements.

MR. WILLIAM FOSTER (Registrar and Superintendent of Records, India Office) endorsed the plea that in dealing with the Indian records free and liberal use should be made of the printing press, especially when the records, as seemed to be the case in some instances, were fast perishing. Printing was cheap enough in India, and plenty of assistance could be obtained in the way of transcription. The great difficulty was to secure accurate proof-reading, to see that the printed paper truly reflected the original. When the Government had at its disposal the services of an enthusiastic student like the author, they could not do better than they were evidently doing, namely, print a number of the District Records; but he hoped they would go further still and print more of the records at Calcutta. In the Bengal Secretariat, as well as in the office of the Board of Revenue, there were immense stacks of papers about which little or nothing was known, and certainly they must contain documents of the utmost importance. All those interested in the study of Anglo-Indian records must welcome the author's efforts in that direction. It was well known what an excellent record Mr. Firminger had in the Calcutta Historical Society, which he practically founded, and which collapsed, he believed, mainly because Mr. Firminger came home to Europe. As editor of its journal, he did very good work, and also in editing volumes of the Society published from time to time. It was gratifying to find he was now studying in detail the contents of the district record rooms.

MR. WILMOT CORFIELD said, as an old resident in Calcutta, and as an old friend of the author, he should be sorry to let the opportunity pass without expressing the pleasure with which he had listened to the paper. Only those who had watched Mr. Firminger's efforts in Calcutta could be aware of the earnestness with which he had set to work in the direction in which his genius and his enthusiasm had led him. There was no man with such a capacity for devouring the most extraordinary mildewed documents; he seemed to revel in them, and always managed somehow or other to get something worth having out of them. The author said, in one part of his paper, that only to look at some of the documents meant that they were bound to be damaged; but that was rather a good thing, because if they were bound to be damaged, they were only damaged to be bound, and the more of them that were put together and rebound, the better it would be for the future. With regard to the Calcutta Historical Society, it was not entirely defunct, and there were many who were still hoping that it would renew its life. There was a

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possibility, he believed, of the Asiatic Society of Bengal taking it over and continuing it in a somewhat modified form.

MR. H. LUTTMAN-JOHNSON said he had spent a good many years of his lifetime in Bengal, and had always taken a great interest in the records. It was over forty-two years since the late Sir William Hunter called attention to the value of the District Records; the subject had been talked about, but it was only recently that something was attempted to be done in a systematic way to bring the documents to the light of day. As had been said, it was no use leaving the work to the spasmodic efforts of hard worked officers; it must be done in the systematic way in which Mr. Firminger had done it, and the records of various districts must be compared in order to learn what was going on at the time when the British first occupied the country. The value of the records was great for various reasons, and one, to which not so much attention had been paid by the speakers, was that they showed the state of the country when the British first took over the Diwani and made themselves supreme. There was a possibility of forgetting what the results of that very ancient Hindu civilisation actually were in any particular part of the country. Bengal was a little different from Upper India, but there was no doubt there had been a king of Bengal and a ruling power, so that it was nothing like a primitive country, but in many ways was highly civilised. For instance, the Brahmins came down from Canouj more than a thousand years ago to improve the Bengalee's knowledge of the elements of Hinduism. These records would show exactly the result that ancient Hindu civilisation had upon the country. It was a country that had been enjoying the benefits of civilisation for at least two to three thousand years, and the records could not be other than extremely interesting, as showing what the results of that long period were. For five years he was Collector at Sylhet, and there saw something of the records, which were of extreme value from the point of view of writing books of adventure, and books interesting to the general public. For instance, the Hon. Robert Lindsay wrote an account of his doings in Sylhet, and it read like a novel. There was no doubt that in every district it was possible to extract material which would form a book equal to any novel. Even from the literary point of view, the publication of the annals was of importance. For instance, in the year 1770 there was a riot in Sylhet. It was put down, and eventually some of the leaders of the rioters escaped to the top of one of the isolated hills, and were attacked and overwhelmed by the Collector. There was a very amusing account of the events given in a letter, which ended up: "The Honourable Board will ask me what has become of these misguided persons. I have to inform the Honourable Board that those misguided persons are no more." Those who had been instrumental in bringing the District Records to light during the last few years had done a very great work for the country of Bengal and for the benefit of the present administrators.

SIR STEUART COLVIN BAYLEY, G.C.S.I., C.I.E., in proposing a vote of thanks to the author and to Mr. Magee for reading the paper, said the name of Firminger was familiar to a previous generation in India. Many years ago, in Bengal, everyone who took any interest in his garden knew the name, because Firminger's "Gardening" was the handbook which guided all who desired to make beautiful gardens in India. The present Mr. Firminger perhaps had done even a greater service, because he did not know that any greater service could be done to the people who took an interest in the early British history of India than to put them in the way of learning the truths about that history, and the facts. Mr. Firminger was also doing something whereby our previous notions of the history of British India had to be corrected. It had been learnt that even such a historian as Macaulay could be hopelessly wrong. From the time when Sir James FitzJames Stephens wrote his little book about Nuncoomar and Impey, all the historians who had studied the early records had found something to improve, and almost invariably showed that the earliest English administrators of Bengal were not such ruffians as they were supposed to be. The question which naturally arose was as to how the records were to be secured in the future. It had been suggested that Government should deliberately take up the work, and certainly it should not be left to the casual enthusiasm of amateurs. He had often thought that nothing could be a better training for a young civilian, in his first year or two, than, after a brief training at a central office, to turn him into the record rooms; it would excite his interest in his work and the people of the district as nothing else can; but even then it was probable he would be taken away in the middle of his work to be sent somewhere else, and therefore a regular fixed staff would be necessary. With regard to the question raised by the author as to whether the flimsy printing paper of the present day would last as long as that of our ancestors, the answer definitely was No. A very interesting inquiry had been made by the Royal Society of Arts some few years ago, when a very strong committee was appointed to inquire into the subject, and the general conclusion they came to was that wood-pulp paper would not last fifty years, and most printing was done on wood-pulp paper. There were good writing papers of course, but these were made of rags, and rags were everywhere being supplanted by cheaper materials, such as esparto grass at best, and wood-pulp at worst, and most of the paper now used for printing would be dust in fifty years. The German Government was so much interested in the subject, that it was manufacturing a special paper for its own use. If a department of the

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Bengal Government took up the question, that would be a point they would have to consider, because it was no use printing on paper which would be dust in the course of a few years.

Sir Steyning Edgerley, K.C.V.O., C.I.E., in seconding the vote of thanks, said he belonged to another part of India, which, they were told, had not made much progress in searching into District Records. Most of the papers which were read before the Society were valuable for the information they gave to people in London, but the present paper would be very stimulating, if published, in India as well. He should be glad to see that it obtained recognition of that character, because people might thereby be found in other parts of India who would do the work that the author had been doing so successfully in Bengal.

The vote of thanks was carried unanimously.

The Rev. J. A. V. Magee briefly returned thanks on behalf of the author and himself, and the meeting concluded.

Mr. G. W. Forrest, C.I.E., writes as follows:—"I have read with considerable interest and utility the Rev. Mr. Firminger's paper on 'The Old District Records of Bengal.' It is a matter of considerable regret that I cannot attend the meeting of the Society, and offer my humble testimony as to the historical worth of the paper. It has not been my good fortune to meet Mr. Firminger, but I have closely followed his work, and I know of its high value to one historical student. The history of British administration from the beginning to the grant of the Diwani is greatly needed, and it can only be written from the old District Records. Many years ago it was proposed by me, as Director of Records, Government of India, that these manuscripts should be removed to Calcutta and kept in a central record office. This is the only way of preserving them from destruction. When they have been placed in a suitable repository, they ought to be fully examined and summarised, and the work, I trust, placed in the hands of Mr. Firminger, who evidently knows what is wanted, in the interests of the study of the history of British administration in India. In Bengal were laid down the first principles of that administration, and to be ignorant of them or depart from them without due consideration is dangerous."

Mr. Wilmot Corfield writes:—"I would suggest the transfer of the executive council of the Calcutta Historical Society to London, and the subsequent carrying on of its work in this city. 'Bengal: Past and Present' could be published just as economically in London as in Calcutta, with an Indian sub-council in constant touch with the London council. The Society (which so far has had a most successful career) might thus be continued on its course without a break. Incidentally, it would serve to maintain in fellowship retired Anglo-Indians and Indians resident in England, interested in historical research in Bengal, while at the same time offering an opportunity for publication of the valuable results of the inquiries and discoveries of Mr. Firminger and other writers. There are more historians and students of Bengal's past at any one time in London than there ever were or ever will be at any one time in Calcutta, while the opportunities in London of acquiring information, pictures, portraits, and other desirable material for the Journal, enormously exceed those that Calcutta could ever offer. The suggestion seems well worth serious consideration."

EIGHTH ORDINARY MEETING.

Wednesday, January 31st, 1912; Sir William H. White, K.C.B., LL.D., Sc.D., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Sacoom, Samuel, Axim, Gold Coast Colony, West Africa.

Wood, Sir Henry J., 4, Elsworthy-road, N.W.

The following candidates were balloted for and duly elected members of the Society:—

Aiyar, Palayam Rajam Sesha, B.A., 10, Kuppumuthu-street, Mount-road, Madras, India.

Baker, Asa George, Messrs. G. & C. Merriam Company, Springfield, Massachusetts, U.S.A.

Barbour, James Foster, Maysville, Kentucky, U.S.A.

Bowles, George Vernon, c/o Messrs. Read Brothers, Ltd., Kentish Town, N.W.

Butt-Gow, H. F. S., Laimakuri, Dibrugarh P.O., Upper Assam, India.

Crouch, Vernon Foster, J.P., c/o Chief Native Commissioner, Salisbury, South Rhodesia, South Africa.

Durrant, Hubert Arthur, Hunstanton, Norfolk.

Eberle, Professor Eugene G., Ph.G., A.M., Dallas, Texas, U.S.A.

Fuchs, Ernest, Box 334, Guadalajara, Mexico.

Gibbs, Eustace L., Tyntesfield, Flax Bourton, Somerset.

Harkness, William Young, Lago Vista, Negritos Payta, Peru, South America.

Hughes, Vivian Arthur Beesley, Ellerslie, Grassfield-avenue, The Cliff, Manchester.

Langton, John James Perez, 421, South Seventh-street, St. Louis, Missouri, U.S.A.

Leitner, Henry, The Leitner Electrical Company, 7, Prince's-street, Westminster, S.W.

Ripper, Charles, 7, Laurel Bank, Lancaster.

Scotland, Alexander Paterson, Keetmanshoop, German South-west Africa.

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Sen, Diwan Mangal, Gujranwala, Punjab, India.

Spence, David, Ph.D., F.I.C., The Diamond Rubber Company, Akron, Ohio, U.S.A.

Windass, John, F.S.A.M., The Hall, Osbaldwick, York.

The paper read was—

RADIO-TELEGRAPHY.

By Professor G. W. Osborn Howe, M.Sc., M.I.E.E.

It is not my intention this evening to describe in detail any of the apparatus employed in the various so-called systems of radio-telegraphy, but rather to explain, in as simple a way as possible, the general principles underlying all these systems, and to indicate the directions along which improvements have been made during the last few years.

Before considering the question of radio-telegraphy itself, one should have a clear idea of what is meant by an electrical oscillation, for electrical oscillations constitute the alpha and the omega of radio-telegraphic communication.

We are all familiar with examples of mechanical oscillations such as occur with the pendulum, the vibrating reed, and the violin string. If we examine these well-known phenomena a little more closely, we find that in every case there is a continual transformation of energy. At one moment the oscillating mass is moving rapidly, and possesses, therefore, a store of kinetic energy depending on the mass and its velocity. The next moment the moving mass is brought to rest, its kinetic energy having been all expended in overcoming gravity, or in stretching or compressing a spring. The energy has not been lost, however; it is stored in the spring, or, in the case of the pendulum, stored as the potential energy of the bob which is now at its highest point. The next moment this static energy is once more retransformed into kinetic energy as the heavy mass is set into motion, and so the transformation goes on until, failing a continual supply, the energy is all dissipated in the unavoidable frictional losses, and the oscillation is damped out. The rate at which it is damped out is called the decrement of the oscillation.

We see that the two essentials to mechanical oscillation are—(*a*) kinetic energy associated with motion; and (*b*) static energy associated with displacement.

Now the electrical oscillation is in every respect analogous to the mechanical. It is the electricity which oscillates or moves backwards and forwards. At one moment the electricity is in motion, producing what we call an electric current, at the next moment the electricity is at rest, and for a moment there is no current, but merely a stationary charge. When the electricity is in motion, the current passing round a coil of wire produces through and around the coil a magnetic field, and this magnetic field represents, or is the manifestation of, a storage of energy in the ether. Just as the kinetic energy of the moving mass is proportional to its mass and to the square of its velocity, so the energy of the magnetic field is proportional to what is called the inductance of the coil and to the square of the electric current.

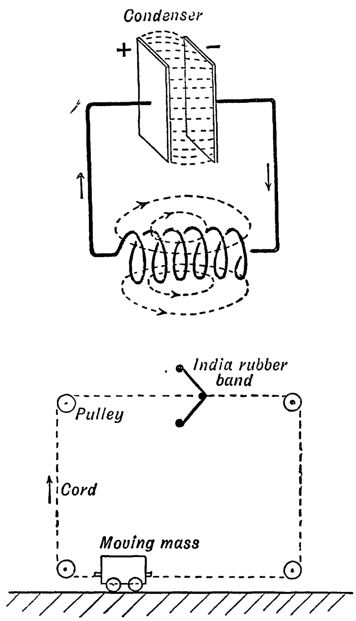

Fig. 1.

In circuit with the coil is some form of condenser, often one or more Leyden jars, consisting simply of two metal plates separated by air, glass, or oil, or some other insulating material. The result of the current is a transfer of electricity from one plate to the other until, when the current, and with it the magnetic field, finally falls to zero, all the energy which a moment ago was stored in the magnetic field is now stored in the space between the two plates as an electric or electro static field. There is at this moment a large pressure difference or potential difference between the two metal plates, and the potential difference causes a current to flow through the coil in the reverse direction, until, a moment later, the condenser is completely discharged, and all its energy is once again stored in the

magnetic field of the coil, only to be once again re-stored in the condenser in the reverse direction. Here, again, the oscillation will be gradually damped out, the frictional resistance of the mechanical analogies being replaced by the electrical resistance of the circuit.

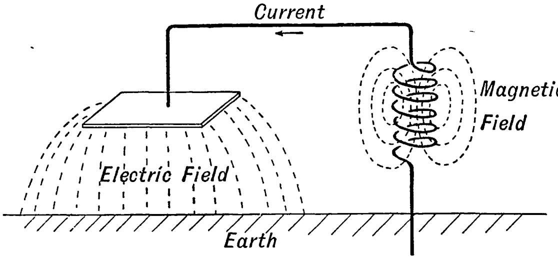

FIG. 2.

The frequency of the mechanical oscillations —*i.e.*, the number of oscillations per second— depends on two things, viz., the mass, m, of the moving part and the yield or displacement, y, of the spring to unit force. In the electrical oscillation, the frequency depends on the two analogous quantities, viz., the inductance, L, of the coil and the capacity, K, of the condenser, by which we mean the electrical displacement or quantity of electricity transferred from one plate to the other by the application of unit potential difference.*

If the plates of the condenser in Fig. 1 be pulled further apart we merely decrease its capacity and increase the frequency of the oscillation. No fundamental difference is made by using the earth as the lower plate of the condenser (see Fig. 2). Figs. 3 (*a*), (*b*), and (*c*) show successive alterations to the shape of the

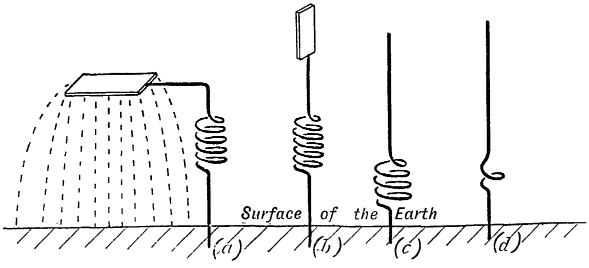

FIG. 3.

upper plate and its distance from the earth or lower plate, until it has ultimately degenerated into a mere continuation of the wire of which the coil is made. Similarly, by decreasing the

* Kinetic energy $= \frac{1}{2}mv^2$. Energy in spring $= \frac{1}{2}yf^2$.
Magnetic energy $= \frac{1}{2}LC^2$. Electrical energy $= \frac{1}{2}KV^2$.
Frequency $= \sim = \dfrac{1}{2\pi\sqrt{m.y.}}$ or $\dfrac{1}{2\pi\sqrt{KL.}}$

number of turns in the coil (Fig. 3 (*d*)) we decrease its inductance and still further increase the frequency. The limit is reached when our oscillatory circuit has become a vertical straight wire. The upper part of the wire acts as one plate of the condenser, while the lower part fulfils the functions of the coil. The two functions of the wire gradually merge into one another, and only at the extreme ends can the wire be considered either a pure condenser or a pure inductance. A plain vertical wire will therefore have a natural frequency of oscillation, which can be shown to be seventy-five million divided by the height of the wire in metres. This gives the number of complete double swings per second. The natural frequency of a given vertical wire can be reduced by increasing its inductance—*i.e.*, by inserting a coil of wire at its foot as in Fig. 3 (*c*).

To set up oscillations in any of these circuits, the circuit is broken by means of a spark-gap, and the condenser is connected to the high-

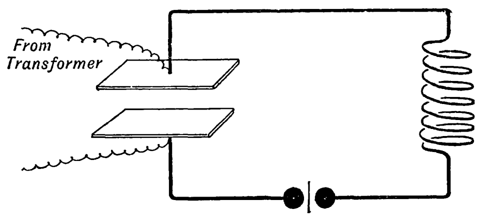

FIG. 4.

tension terminals of a spark coil or of an alternating current transformer (Fig. 4). This charges up the condenser and raises the potential difference across the spark-gap to a very high value (5,000 to 30,000 volts) many times per second. If the distance between the spark balls be suitably adjusted, the tension in the air-gap will succeed in breaking it down, and the oscillatory circuit will be completed through the spark. The condenser will discharge through the spark and the inductance, and the electricity will surge backwards and forwards in the way we have already considered.

This must all occur during the very short interval that the spark-gap is bridged by the spark, for when the spark ceases the circuit is opened, and no further oscillation **is** possible until the condenser is once more charged, and the potential difference raised once again to the value required to break down the spark-gap.

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In Marconi's earlier stations the aerial was set oscillating in this way (see Fig. 5). This was called working with a plain aerial, but is now more generally known as a pre-charged aerial. It is little used at the present time.

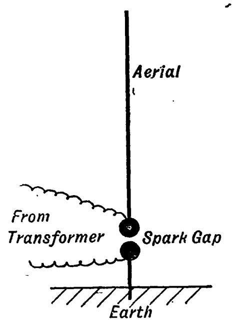

FIG. 5.

There is an important difference between the oscillations set up in such a circuit as that shown in Fig. 4, and that set up in the aerial in Figs. 3 (*d*) and 5. In Fig. 4 the disturbance is confined to the immediate neighbourhood of the circuit, and the energy alternates between the magnetic field of the coil and the electrostatic field of the condenser with only one source of loss, viz., that due to the resistance of the circuit. In Figs. 3 (*d*) and 5, however, where the

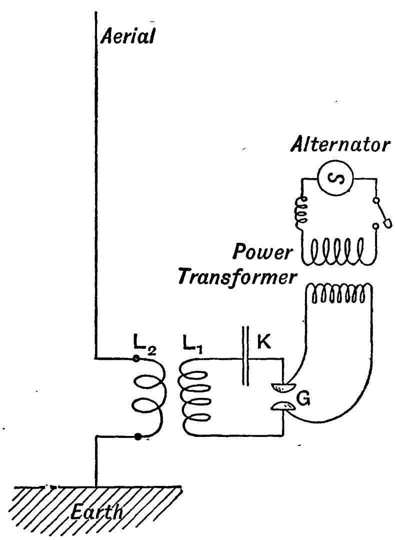

FIG. 6.

electric and the magnetic fields alternately occupy the same space, the disturbance is more far-reaching, and the train of oscillations occurring with each spark causes a train of waves in the ether to spread out from the aerial in all directions, like the ripples from that point in a lake where a stone has just entered the water. These pulses or waves carry with them, and are the manifestations of, energy, so that the oscillations in the aerial are damped out more rapidly than would be the case were the only loss of energy that due to resistance.

The arrangement shown in Fig. 5 was soon given up in favour of another arrangement known as a coupled aerial, and shown in Fig. 6. This figure may be taken as representing diagrammatically the sending apparatus of almost every radio-telegraphic station in commercial use at the present day. Here we have two oscillatory circuits—one called the primary, containing an inductance, L_1 a condenser, K, and a spark-gap, G, exactly as in Fig. 4; and the other the aerial itself with a coil or inductance, L_2 at the base exactly as in Fig. 3 (*c*). The coils L_1 and L_2 are coupled together—*i.e.*, they are placed so near that the magnetic field produced by a current in L_1 passes to a certain extent through the turns of L_2. L_1 and L_2 constitute the primary and the secondary of a transformer, and the oscillatory currents occurring in L_1, whenever a spark passes at G, induce electromotive forces in L_2, and set up oscillations in the aerial, *especially if the two circuits are adjusted to have the same natural frequency.* This latter operation is called tuning the circuits, and is exactly analogous to the adjustment of a violin string until it has the same natural fre-

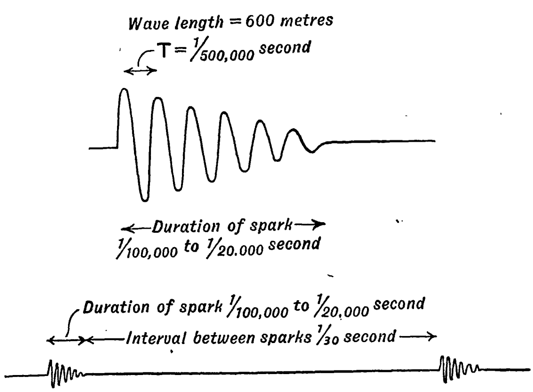

FIG. 7.

quency of vibration as the corresponding string in the piano.

Each spark causes a damped oscillation in the circuit L_1, K, G (Fig. 6), and this causes a somewhat similar oscillation in the aerial, from which electro-magnetic waves are radiated in every direction over the earth's surface. The total time occupied by the aerial in sending out the

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train of waves may be from $\frac{1}{100000}$ to $\frac{1}{5000}$ of a second, as shown in Fig. 7, where the oscillatory current is represented as making about six complete oscillations before being completely damped out. Nothing further will happen until the next spark occurs, which in Fig. 7 is supposed to be one-thirtieth of a second later.

Let us now turn from the sending apparatus and follow the damped train of waves which, as the result of the spark, has been sent out from the aerial, and is travelling in all directions through the ether with the velocity of light—viz., 300,000 kilometres per second (see Fig. 8).

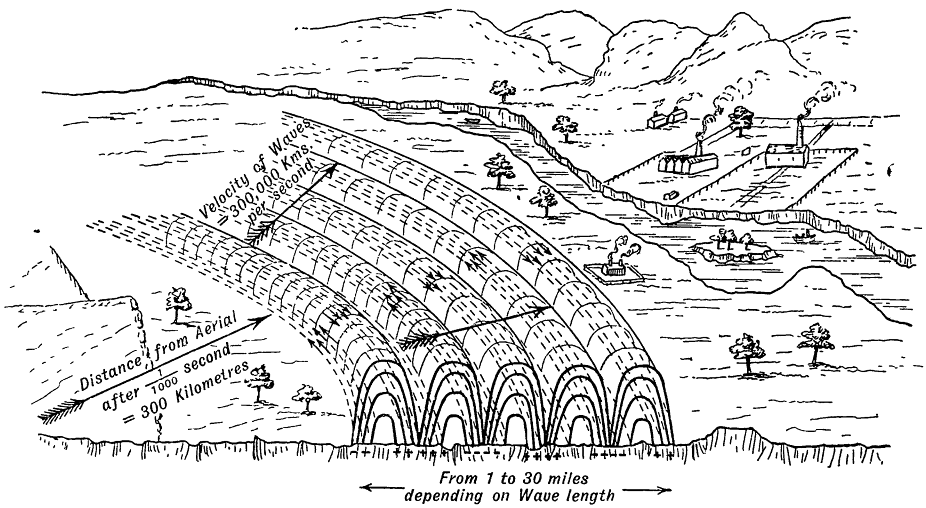

FIG. 8.

Every vertical conductor, whether lightning conductor, rain-water pipe, or radio-telegraphic aerial, encountered by the electro-magnetic wave has electro-motive forces induced in it, and extracts a little energy from the wave. If the vertical conductor, which we have already seen to be an extreme form of oscillatory circuit, be tuned so that its natural frequency is equal to the frequency of the passing wave, the effects of successive impulses will be cumulative, and the oscillatory current produced in it will be large compared with the current which would be produced were the aerial not tuned to the received wave.

To complete the communication between the two stations, it only remains to detect the presence of this minute high-frequency current in the receiving aerial. The most sensitive and probably the most widely used method is shown diagrammatically in Fig. 9. The currents in the coil L_3, at the foot of the aerial, induce currents in the circuit, K, L_4, which is tuned to have the same frequency and loosely coupled with L_3. The tuning is carried out by means of the adjustable condenser, K, which is varied until the best results are obtained. After what has been said it will be readily understood that in transferring the energy from the aerial to the loosely-coupled tuned circuit K, L_4, there will be a weeding-out of all electro-magnetic disturbances which have not the correct frequency.

The detector shown is of the mineral contact

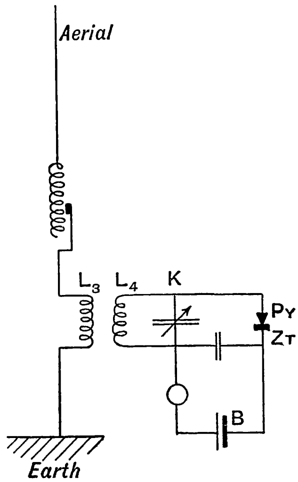

FIG. 9.

type, consisting simply of a piece of zincite in contact with a piece of pyrites. Many other minerals can be used, but nothing seems to exceed these two in sensibility. A telephone receiver is placed in series with the detector

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across the terminals of the condenser, *K*. The telephone-receiver is shunted by a condenser of such a capacity that it acts as a conductor to the high-frequency oscillations, enabling them

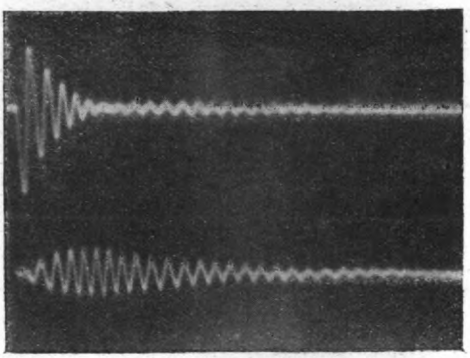

FIG. 10.

to pass through the detector without passing through the highly inductive telephone-receiver; to currents of telephonic frequency it must act as an insulator, thus forcing them to pass through the telephone-receiver. The cell, *B*, is sometimes used to improve the action of the detector, but it is not essential. Whenever high-frequency current passes through the detector, the point of contact is heated, thermal electromotive forces are produced, and a small current is sent through the telephone-receiver.

This current ceases as soon as the point of contact returns to its normal temperature. The sounds thus produced in the telephone-receiver constitute the signal.

Having thus glanced at the receiving station, let us now return to the sending station, and

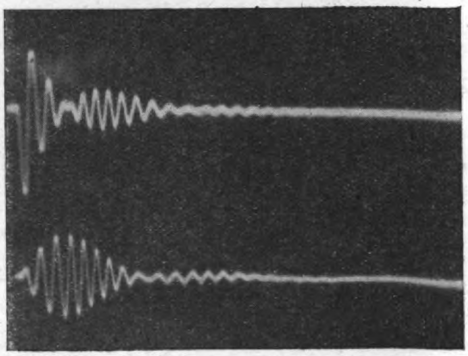

FIG. 11.

consider the various points a little more in detail. With the ever-increasing number of radio-telegraph stations, it is essential to avoid, as far as possible, interference with other stations, and since the waves emitted by an ordinary aerial radiate equally in every direction over the earth's surface, the receiving apparatus should be very discriminating and respond to those waves intended for it, while remaining relatively unaffected by waves possibly far more powerful, but sent out by other aerials. To make this possible it is essential that the waves sent out by every station should be of such a nature that discrimination is possible.

Now we have seen that to discriminate against any wave which we do not wish to receive, we must tune our receiving apparatus—both aerial and secondary circuit—to some other frequency, either higher or lower, than that of the disturbing wave. If the sending station with which we wish to communicate is sending with exactly the same wave-length as the disturbing station, we shall tune out both stations at the same time, unless one is much stronger than the other, but

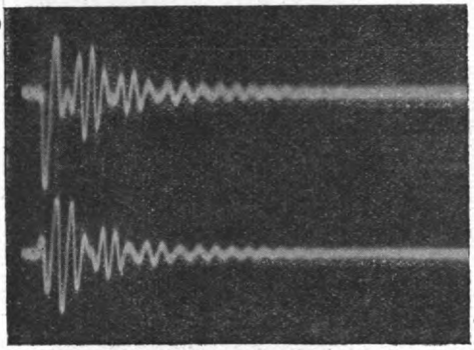

FIG. 12.

if the wave-lengths differ it may be that, when tuned up to the required station, the interfering station is tuned out—*i.e.*, if not inaudible it is so soft as to cause no trouble. The sharpness of tuning which can be obtained, or the amount by which the two sending stations must differ in wave-length to allow of the tuning out of one of them, depends entirely on the nature of the train of waves sent out as the result of each spark. If it be a well-sustained train—*i.e.*, if the damping or decrement be small—very sharp tuning will be possible, but if it be very rapidly damped out the disturbance will be more of the nature of an explosive shock than of a train of waves, and it will be found impossible to tune it out. A plain or pre-charged aerial must always be a great offender in this respect, for, whatever the nature of the subsequent train of waves, it always commences with a sudden shock of no definite frequency, whereas in the

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coupled aerial the shock is confined to the primary circuit and the oscillatory current is gradually built up in the radiating aerial.

Consider now the effect of varying the coupling between the two coils, L_1 and L_2, in Fig. 6. If the coupling be loose—*i.e.*, if the coils be far apart—the transfer of energy from the primary circuit to the aerial will be slow, the reaction of the aerial on the primary circuit will be small, and the currents will be as shown in the oscillogram, Fig. 10, where the upper curve represents the current in the primary circuit, K, G, L_1, and the lower curve that in the aerial. The lower curve will, therefore, indicate the nature of the train of waves sent out by the aerial. The transfer of energy being slow, much of it will be dissipated in the spark-gap, and it is impossible with such an arrangement to transfer more than about 30 per cent. of the primary energy to the aerial. If we try to improve the efficiency by coupling the coils L_1 and L_2 more closely, and thus hastening the transfer of energy to the aerial, a new difficulty arises. When all the energy has been transferred to the aerial the current in the primary oscillatory circuit will have fallen to zero, but the primary circuit is still closed through the hot spark-gap, which does not instantly lose its conductivity, and the aerial coil L_2 will now act as the primary of the transformer, and L_1 as the secondary, and the energy, or what remains of it, will surge back into the circuit, L_1, K, G. This phenomenon is well known in all coupled oscillatory systems, and can be easily shown by suspending two pendulums from the same flexible support. The oscillograms, Figs. 10, 11 and 12, were taken under identical conditions, except that the coupling was made successively closer. The lower curve of Fig. 12 shows, then, the nature of the waves emitted by the aerial with tight coupling. There is no sustained train of waves of one definite frequency, but a succession of surges or beats. A similar result would be obtained from two aerials side by side, sparking simultaneously, but of different wave-lengths. When we remember that the receiving apparatus is really a harmonic analyser, picking out and responding to waves of its own natural frequency, it is easy to see that the best result will not be obtained when the receiving aerial has the same natural frequency as the sending aerial. If the magnitude of the signals received, as the natural frequency of the receiving apparatus is altered, be plotted, curves are obtained similar to those in Fig. 13, where each curve refers to a certain given coupling in the sending apparatus.

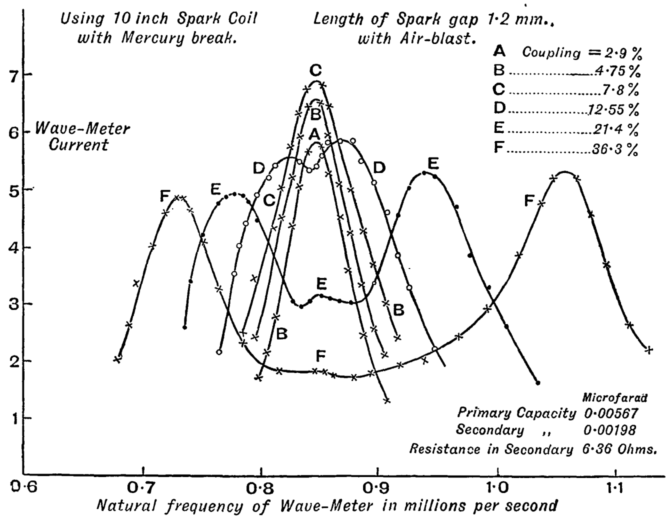

Fig. 13.

With the ordinary spark-gap it is thus seen to be impossible to increase the coupling much above 7 or 8 per cent. without sacrificing sharpness of tuning, and thus causing undue interference with stations working at other wave-lengths. Apart from the question of interference there is little increase of efficiency to be obtained by increasing the coupling beyond this value. Most stations are working at present in this way with loose coupling, and consequent low efficiency.

In Fig. 13 it will be noticed that when the coupling is tight, the aerial oscillation contains waves of three definite frequencies

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—one high and one low, corresponding to the constituents of the beats — and one of the natural frequency of the aerial alone. This last shows that during a part of the time

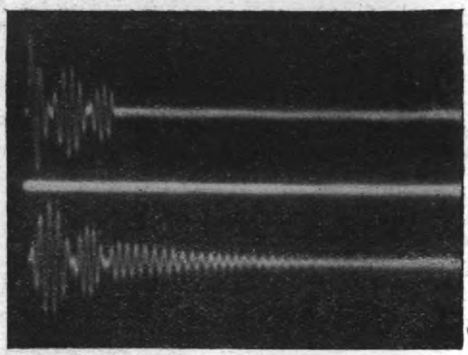

FIG. 14.

the aerial oscillated freely, uncoupled from the primary circuit. The reason for this can be seen from the oscillogram, Fig. 14. In the experiment to which Fig. 13 refers, the spark-gap was exposed to an air-blast, so that whenever the amplitude of the current in the primary oscillating circuit was small, there was a tendency for the air-blast to remove the column of hot air and metallic vapours, and thus extinguish the spark. This will obviously occur at a moment when all the energy is oscillating in the aerial, and will prevent it surging back into the primary circuit. The aerial will now continue to oscillate at its natural frequency until the energy has been radiated or dissipated. In Fig. 13 not only was there an air-blast, but the electrodes were comparatively large and the spark-gap short,

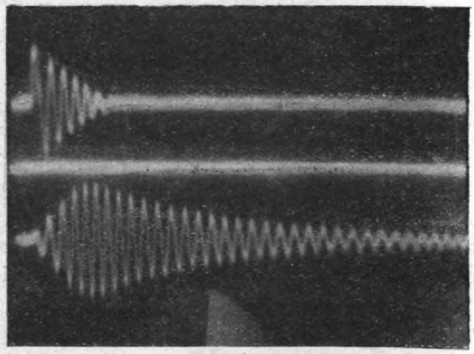

FIG. 15.

so that no part of the spark was far removed from a large mass of cold metal tending to cool the heated air, and condense the metallic vapour, and thus lower the conductivity of the spark. This quenching of the spark was discovered in 1906 by Professor Max Wien, and was afterwards taken up by the Telefunken Company, who are using a form of gap which has a strong tendency to quench. If the quenching of the spark is perfect, the currents will be as shown in oscillogram, Fig. 15. The gap acts as a very quick-acting minimum-current cut-out, and opens the primary oscillating circuit at the first opportunity—viz., when all the energy has been transferred to the aerial. The time during which the two circuits are coupled is very short, the loss in the spark-gap is reduced, and the major portion of the energy oscillates freely in the aerial and is radiated as a damped train of waves at its natural frequency. In this way it is claimed that 75 per cent. of the output of the alternator is transferred to the aerial.

It is obviously advantageous to shorten the

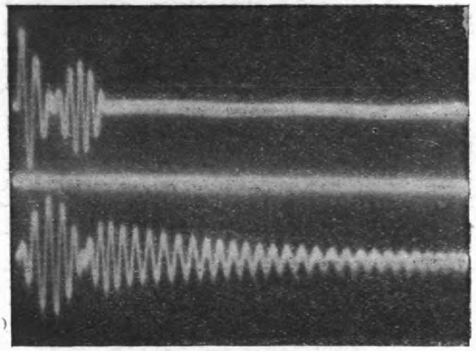

FIG. 16.

duration of the spark as much as possible by tightening the coupling between the coils L_1 and L_2, and thus hastening the transfer of energy to the aerial. If this be overdone, however, the gap will fail to quench at the first minimum, and we may get the conditions shown in Fig. 16, or even Fig. 14, with a great loss both in efficiency and in sharpness of tuning. Wien first obtained quenching by the use of very short spark-gaps, and this is the method used by the Telefunken Company, although other methods have since been discovered. The spark is made to occur between the parallel faces of discs of copper or silver, placed about $\frac{1}{100}$ in. apart, the discs being separated by thin annular rings of mica, which also serve to shut the sparking spaces off from the air. The number of these discs in series depends on the voltage and power required. This form of gap is undoubtedly complicated and expensive, not only in first cost but also in

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upkeep, and the increased efficiency is obtained by the sacrifice to a certain extent of reliability and simplicity.

In addition to the interference from other stations, there are the atmospheric disturbances

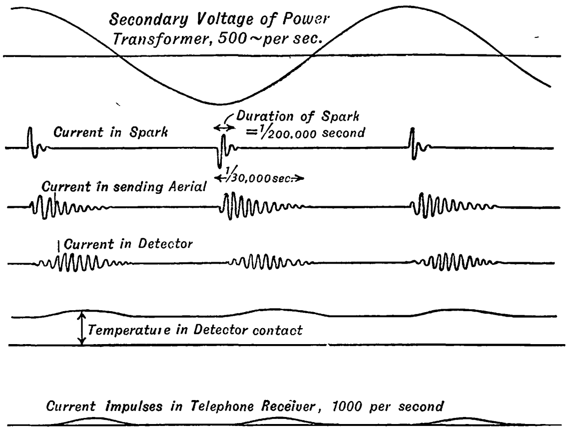

FIG. 17.

due to lightning flashes somewhere on the globe. Each flash sends out a powerful electro-magnetic pulse of explosive suddenness. It is practically impossible to tune these out, as any frequency they may have is quite indefinite, and they are often much louder than the signals being received. It is here that great improvements

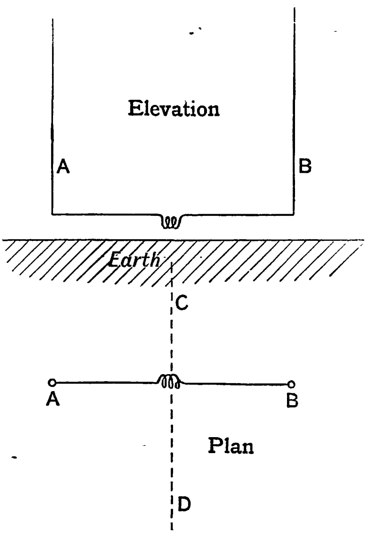

FIG. 18.

have been made by giving the signals a clear musical note, easily distinguishable from the crackling noises due to atmospheric disturbances. A study of Fig. 17 will show that the pitch of the note heard in the telephone-receiver depends entirely on the number of sparks per second, while the purity of the note depends on the regularity of the sparks. By using a high spark frequency—*i.e.*, a large number of regularly occurring sparks per second—a clear musical note is obtained, but, contrary to expectations, the telephone-receiver shows no greater sensibility than with the low spark frequency.

By using an alternating-current generator giving 500 cycles per second as the source of supply, and adjusting the voltage or gap until we get a spark every half-cycle, a pure note, with a pitch of 1,000 will be obtained—that is, a high, piping note easily distinguishable from other sounds. To ensure regularity the gap must be kept cool, and the after-effects of each spark quickly removed. With the ordinary long gap this can be done by means of an air-blast or by making the electrodes in the form of large discs, and revolving them by means of a motor, as is done by the Marconi Company in their large stations. In the short, quenched spark-gaps the spark has to be quenched about $\frac{1}{200000}$ second after it has jumped across, so that after $\frac{1}{1000}$ second the gap should have lost all traces of the spark.

The quenching action has thus to play a double part, the first affecting the nature of each spark and the resulting oscillation, and the second affecting the regular succession of sparks.

One cannot but be struck by the inefficiency

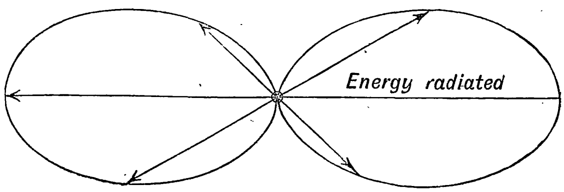

FIG. 19.

of radio-telegraphic communication when looked at from the point of view of the transmission of energy. In some recent experiments made on ships of the United States Navy, it was found that at a distance of 500 miles the current in the sending aerial had to be 30 amperes to produce in the receiving aerial the current of 40 micro-amperes, which was found to be necessary for good signals. This great loss is mainly due to the world-wide radiation of the energy from the sending aerial. Seeing that the electro-magnetic

wave is of the same nature as light, one would naturally suggest putting a reflector behind the aerial so as to throw the ray forward. It must be remembered, however, that a reflector must be large in comparison with the length of the wave, so that whereas a reflector as large as the head of a pin is quite efficient for light with a wave-length of $\frac{1}{2000}$ millimetre, an efficient

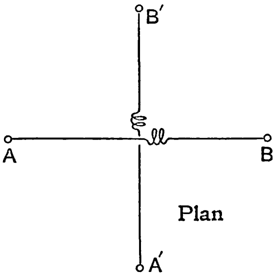

FIG. 20.

reflector for a wave-length of 6 kilometres, or even of 300 metres, is out of the question. Attempts are being made, however, to direct the electro-magnetic waves in the desired direction. Two methods have been successfully employed—one due to Bellini and Tosi, the other to Marconi. The former is easily understood, and is based on well-known principles. The reasons for the directive action of Marconi's bent antenna have been much discussed, and several possible theories have been worked out. In the simplest form of apparatus employed by Bellini and Tosi two vertical antennæ are employed, joined at their lower ends by a horizontal insulated wire, in the middle of which is inserted the secondary coil of the sending transformer (Fig. 18). When the A antenna is charged positively the B antenna will be charged negatively, so that when A is sending

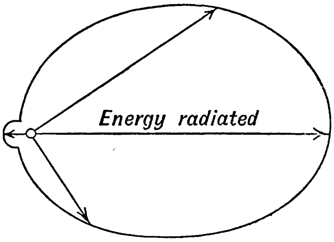

FIG. 21.

out a wave-crest, B will be sending out a wave-trough, and *vice versa*. Anywhere on the line C, D these two waves will neutralise each other, but if the distance A, B be rightly chosen the crest emitted by A will arrive at B just as B is also emitting a crest. At the same moment A is emitting a trough, and the trough which half a period before was emitted by B will just have arrived at A. Hence, anywhere in the line A, B, produced in either direction, the waves emitted by the two antennæ are additive.

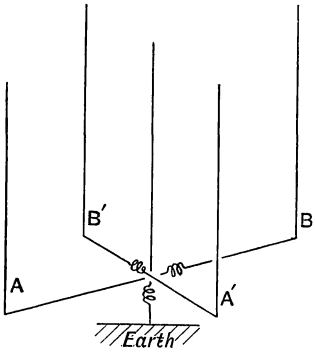

FIG. 22.

A diagram representing the energy radiated in various directions will be somewhat like Fig. 19. With this arrangement the radiation is equally powerful, both in the desired and in the opposite direction. If we wish to alter the direction, we must either arrange to rotate the whole aerial, or we must duplicate the whole arrangement at right angles. There will then be four vertical antennæ used in diagonal pairs (Fig. 20). The primary coil of the sending transformer is capable of rotation, so that it can influence either the secondary coil of A, B, or that of A^1, B^1, or partly one and partly the other.

In this way the line of maximum radiation can be rotated at will. Bellini and Tosi have gone a step further, however, and have done away to a large extent with the backward radiation as shown in Fig. 21, which shows the actual results obtained. This has been attained

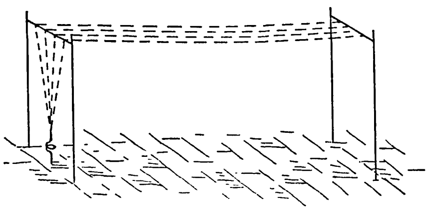

FIG. 23.

by erecting an ordinary vertical antenna halfway between the outer antennæ—*i.e.*, immediately over the transformer coils, Fig. 22. This antenna is earthed through a separate secondary coil, which is acted on by the same primary as

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the other secondary coils, but the best results are obtained by slight modifications, into which we shall not enter.

The radiation from this central antenna will be uniform in every direction. If now, just as the crest of a wave, emitted by the central antenna, reaches the outer antennæ *A* and *B*, the former is emitting a trough and the latter a crest, the radiation in the direction *A*, *B* will be strengthened, and that in the direction *B*, *A* weakened. The whole action depends on the correct magnitudes and phase relations of the waves emitted by the central and outer antennæ.

With the Marconi bent antenna (Fig. 23) the results obtained are somewhat similar, although not so pronounced. The maximum radiation is in the opposite direction to that in which the upper horizontal part of the antenna points, and this direction cannot be altered, but must be decided when the antenna is erected.

DISCUSSION.

Mr. James Swinburne, F.R.S., in opening the discussion, said the author was a very bold man, who had tackled the problem of trying to explain the principles of wireless telegraphy to a non-specialised audience in an hour, but he had succeeded very well indeed in his difficult task. In dealing with the question of the Marconi system of directing, the author had stated that it was very difficult to say how it worked. In Fig. 18 two aerials, A and B, were shown, with the induction coil in the middle. To complete that, it was possible to connect the tops of the aerials, a complete circuit then being obtained. If one side, B, was then removed, an imperfect model of the Marconi arrangement was obtained, which would tend to send the messages along both directions, but better in the direction on which the side was more perfect. He could not help thinking that that was a popular explanation of the directive action of the Marconi method. The author had also pointed out how the other arrangements sent out energy in special directions, and he would like to ask Mr. Howe whether there was not perhaps some slight fallacy underlying his assumptions. It did not follow usually that because it was impossible to pick up energy where there was interference, any less energy was sent out from the aerial, and that therefore the efficiency in the other directions, or the efficiency as a whole, was increased. That was a matter which he thought was worthy of consideration. In his opinion the author had been a little hard on wireless telegraphy when he referred to its inefficiency, because, personally, he could not help feeling that wireless telegraphy was one of the most efficient means of communicating generally in all directions that man had invented. If communication was established between two fixed points, *a* and *b*, it was natural to expect efficiency; but for communicating in all directions wireless telegraphy had an extraordinary property, namely, that the energy varied substantially inversely as the distance and not inversely as the square of the distance. The energy in the case of incandescent lamps or any other light varied as the square of the distance and not as the distance, the result being that wireless telegraphy was enormously more efficient than the sort of radiation generally dealt with. In another form of communication, such as induction telegraphy, which was proposed at one time and worked out to some extent by Sir Oliver Lodge, a method was obtained which varied inversely as the cube of the distance, and fell off therefore very quickly indeed. When one realised what wireless telegraphy had done it was only possible to come to the conclusion that it was not inefficient, but, on the other hand, that it was one of the most extraordinarily efficient means of general communication that had hitherto been invented.

Mr. W. Duddell, F.R.S., thought that one of the main features of recent progress in wireless telegraphy was that by means of an enormous number of experiments carried out by many investigators, success has been obtained in getting a very much better note than had been used in work on telephone-receivers, which had rendered it possible to read signals in spite of atmospheric disturbance. One of the greatest difficulties in connection with wireless telegraphy at the present day was atmospheric disturbance. Even in the latitudes of this country, where lightning at the present time of the year was comparatively rare, there was an enormous amount of atmospheric disturbance every evening, which took the form of irregular cracks. It seemed quite impossible to tune them out in any way. The author had stated that those cracks had no apparent frequency of their own. Personally, he did not think that was quite accurate, because it appeared that the longer the wave-length that the aerial was adjusted for, the more the system suffered from atmospherics, as if the atmospheric disturbances themselves were irregular disturbances, of which the greater number had a long wave-length, so that more of them were heard if the system was adjusted for long wave-lengths. The old form of crackling spark sounded so much like the click of the atmospheric, that dots were put into the Morse alphabet, so that it was easily possible to turn d's into b's. With the quicker spark a more musical note was obtained, on which it was possible to fix one's attention, and if one was expert it was possible to read it right through even under very considerable atmospheric disturbance. He wished the author had carried the question of atmospheric trouble a little further, and given the latest results obtained with regard to stopping-out by special devices some of the more pronounced atmospheric disturbances. He believed that great success had been achieved in that direction within the last year by Mr. Marconi.

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Mr. A. C. Brown asked the author, in his reply, to state what, in his opinion, were the possibilities of wilful interruptions of wireless telegraphy in times of war. After carefully considering the subject, he had come to the conclusion that the first effect obtained under such circumstances would probably be the sudden cessation of all effective wireless telegraphy. It seemed to him that if a ship was sent out equipped with apparatus as powerful as the most powerful stations that it wished to interrupt, with the means of continuously varying the inductance and capacity in such a way as would first produce long wave-lengths, and then successively smaller wave-lengths, and repeating that mechanically by turning a wheel, it would be possible to interrupt any wave-lengths capable of being used in practical wireless telegraphy. It might be necessary to tune exactly to a wave-length in order to read it, but it was not necessary to know the wave-length in order to interrupt it. The point was, he thought, an important one, because so much depended on wireless telegraphy during war.

Colonel C. Napier Simpson asked whether, on a battlefield which covered only a small distance, it would be possible for an enemy so to disturb the wireless telegraphy apparatus that it would be absolutely useless. There were one or two points in connection with wireless telegraphy on which he was very much in the dark. For instance, he understood that if two ships were 500 miles apart, and were on north and south courses, they would easily be able to pick up wireless signals from each other, whereas they were not able to do so if they were only 200 miles apart, and their courses were east and west. He also understood that wireless messages sent to some places at night were easily received, while in the daytime it was almost impossible to communicate by means of wireless telegraphy with the same places. On the other hand, he understood that some stations could easily receive messages by day and not at night.

Professor Osborn Howe, in reply, said that Mr. Swinburne had pointed out that the Marconi directed aerial could be explained roughly by means of the Bellini and Tosi method. As a matter of fact, that was the line upon which the most recent mathematical investigations had gone. The most recent mathematical explanation had considered that between the open end of the Marconi aerial and the ground fictitious aerials could be imagined, and it was by means of assuming those fictitious aerials, in which the induced currents of the earth came into play, that the most reasonable explanation of the Marconi aerial had been given. The question of whether the Bellini and Tosi method was more effective in the maximum direction than a plain aerial was open to a certain amount of discussion. Bellini and Tosi had given results to show that it was, but personally he thought that in order to make comparative tests it would be better to compare the Bellini and Tosi aerial with an ordinary aerial on which the same amount of money had been spent; for instance, instead of setting four aerials up at the corners of a field, by putting the amount of the additional capital thus expended into a much larger aerial in the middle of the field, the directive effect would be lost, but it was quite possible that more energy would be obtained in the maximum direction than with the Bellini and Tosi method. The Bellini and Tosi method did away to a large extent with interference with other stations, and also with the danger of being picked up by other people. As Mr. Swinburne pointed out, electromagnetic wave radiation was far more efficient than ordinary light radiation, because as he (the author) showed in one of the figures, the waves were not spreading up and down except to a limited extent. The radiation was practically between two parallel planes in all directions. Therefore, the space occupied by the wave only increased as the distance, whereas, if it was spread out spherically the space occupied by the energy would vary as the square of the distance. Mr. Duddell had, to some extent, misunderstood the remarks he made in the paper. He did not mean to convey that atmospherics had no frequency, and it would be noted that he said in the paper: "It is practically impossible to tune these out, as any frequency they may have is quite indefinite"—he might also have said "unknown." Most of the atmospherics had a frequency, but one was quite in the dark as to what they would be and when they were coming, and they were probably all different, so that any frequency they might have was quite indefinite and unknown. He believed a lot had been done in the direction of stopping them out. In the trans-Atlantic work, he believed that great success had been achieved by using two Fleming valves in parallel, adjusted to have different sensitiveness, so that the by-pass valve was not quite sensitive enough to shunt the signals that one desired to receive. The signals desired had to come through the working valve when the sensitiveness could be adjusted, but if an atmospheric suddenly came the powerful aerial then succeeded in breaking down the additional resistance in the by-pass and was shunted. He agreed with Mr. Duddell that a lot of work had been done on the subject, and he believed the Marconi Company were meeting with great success in that direction. Mr. Brown had referred to the question of spoiling the enemy's wireless telegraphy in time of war. Personally he thought it was rather difficult to say what would happen in time of war; the things that happened in times of peace were quite bad enough. He believed various arrangements had been devised for running up and down the scale and blazing away at full power on the chance of spoiling wireless messages. It was a fact, as Colonel Simpson had stated, that wireless signals did travel better from north to south than from east to west, but he did not believe any explanation had yet been given why they did so. It was also a fact that, as a rule, electro-magnetic waves could travel with far less absorption at night than at day. Wireless stations

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would, as a rule, guarantee a longer range at night than by day, but the night range was very uncertain. The day range seemed to be more or less fixed, and there was not the same variation in the day range that there was in the night range. Colonel Simpson also referred to the irregularity in wireless stations, one station seeming to work all right, while another station a little way off could not work at all. Recently it was possible to work quite well between Ireland and one station in America, but not to another station, although the distance between the two American stations was not great; there was some local obstruction in the way, some etheric fog bank, which absorbed the atmospheric waves. The explanation that was usually given for the difference between day and night working was that the ultra-violet light from the sun ionised the air, making it partly conducting, and if the electro-magnetic waves were passing through a conductor and not through a perfect dielectric the energy would be absorbed. That, however, could not be a perfect explanation; it did not account for the peculiarities that occurred during the night. It was a fact that if one listened in England to the messages received from America it was possible practically to hear the sun rise and set on the Atlantic. During the day the signals were almost inaudible, and as darkness fell across the Atlantic the signals gradually became louder and louder.

Colonel Simpson said he understood there were stations in Africa in which the reverse phenomenon occurred, the hearing being much better by day than by night.

Professor Osborn Howe said the statement was quite new to him that any station worked regularly better by day than by night; as a general rule, the night sending was better than the day, but he was afraid he could not explain why that was the case. He believed that if the enemy were clever enough they could prevent wireless telegraphy working. If they had powerful wireless apparatus and set themselves to do so, there was nothing to stop them from absolutely blocking every station within a certain radius. For instance, if anybody at the Eiffel Tower wished to prevent wireless messages being sent from England, France, or Germany, for twenty-four hours, he did not think it would be very difficult for them to do so. They would simply run up and down the scale and blaze away at full power, and he believed that would stop all wireless communication within several hundred miles.

The Chairman (Sir William H. White), in proposing a cordial vote of thanks to the author for the wonderful epitome he had given of the science of wireless telegraphy, said that he was primarily guilty of the fact that the author had been asked to deliver a paper before the Society. At the Portsmouth meeting of the British Association, Professor Howe gave a most admirable address on the advances made in wireless telegraphy, accompanied by a demonstration which he wished could have been repeated that evening, because it was one of the most effective demonstrations he had ever seen. Not only did the author on that occasion capture the time signal sent out at noon from Wilhelmshaven, but he also unintentionally captured a local wireless message in quite a different tune that was being sent from Portsmouth to the Admiralty. Although personally he was not an expert in the subject, he could distinguish quite clearly between the messages that were being sent simultaneously, the one from Portsmouth and the other from Wilhelmshaven. With regard to the question of interference with wireless messages in times of war, that was actually done during the war between Japan and Russia in the Far East, when he believed a Japanese operator took a dictionary and proceeded to reel off as many pages as he could on his instrument. The Russian ships, which hoped to receive wireless messages, did not get any at all. That he believed could always happen. It represented an expenditure of energy which was perhaps less harmful than other expenditures of energy that occurred in time of war.

The resolution of thanks was carried unanimously, and the meeting terminated.

CORRESPONDENCE.

RESPECT FOR LABOUR IN INDIA.

I am solicitous to record in our *Journal* a brief but emphatic protest, so far as India is concerned, against a very widely-circulated, sweeping statement recently made by the Rev. Lord W. Gascoyne Cecil, to the effect that the difference of position between the working man of the East and of the West is not solely due to a difference in their wages, but because physical labour in the East "is universally despised." The direct opposite is the fact in India—India of the Hindus—unless where European industries, and concomitant English ideas of respectability, now prevail. There is a beautiful saying among Hindus: "The hand of the workman [even the dyer's] in his work, is always pure"; and it is a very beautiful observance among them, in the streets and high roads, to give way to a working man *in his work*. From the day I first noted it, I have myself conformed with the practice, which with the Hindus is a rite; and when in this country my so doing has haply been observed, as by some working man carrying an unmanageable weight, his instant outburst of warm-hearted thanks has ever proved an all-sufficient proof for me of the superiority of Eastern to Western civilisation in its sentiment toward labour.

It is also a pity that the writer referred to should seek to identify Christianity with civilisation. Once it was so with me; and arguing with the venerable, white-bearded Arab pilot who was taking the

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Honourable East India Company's s.s. "Ajdaha" up the Euphrates to the bombardment of Mohammerah [and who talked all the while of Abraham, and Isaac, and Ishmael, as if they were still living among us], on the evidence afforded by the superiority of Western over Eastern civilisation, of the practical superiority of Christianity over all other religions, he, pointing to the cannon and the heaped shot and shell about us, simply asked: "Are these things in which you so excel us of the inspiration of God or the devil?" We argued no more that day. But the great guns overwhelmingly prevailed in the bloody work whereto they were so expertfully and so well-approvedly piloted by this ancient autochthon, "out of Ur of the Chaldees."

GEORGE BIRDWOOD.

January 30th, 1912.

AEROPLANE EFFICIENCY.

With reference to Mr. Berriman's very interesting paper in the *Journal* of December 1st, may I indicate the following points:—

(1) "Frictional resistance formula."—In my papers in the *Aeronautical Journal* I have given the value: $R = 0 \cdot 000015\ AV^2$ for single surfaces (R in lbs., A in sq. ft., V in feet per second). This became $0 \cdot 00003\ AV^2$ for double surface, or $0 \cdot 000014\ AV^2$ (V in miles per hour), as compared with Mr. Berriman's value, $0 \cdot 000018$.

(2) *Re* "Efficiency."—This expression originated with Turnbull. "Drift-ratio" conveys the meaning most satisfactorily.

(3) *Re* "Angle" and methods of measuring it.—Gliding experiments (*vols-planés*) lead to fairly correct values when worked out on the basis of minimum potential. Lanchester has overlooked the fact that an aeroplane must run in the direction of least resistance. With cambered surfaces the gliding angle may be equal to or a little more than the "deflection angle."

HERBERT CHATLEY.

The College, T'ang Shan,
January 10th, 1912.

OBITUARY.

GEORGE WEDLAKE.—Mr. George Wedlake died suddenly on the 22nd January at the age of sixty-three. After spending some time as a young man in the West Indies, Mr. Wedlake returned to London and devoted himself to journalism. He was a leader-writer on the *Echo*, and financial editor of the *Star*. He was afterwards appointed editor of *Talk*, and on the demise of that journal he became editor of *To-day*, *Madame*, and the *Imperial Review*. In 1905 he was elected a member of the Royal Society of Arts, and since that date he was a regular contributor to the *Journal*. A man of wide experience and varied interests, he kept himself well informed of all developments in the industrial world, and this knowledge was reflected in his "Home Industries," which have been a constant feature of the *Journal* for the last seven years.

GENERAL NOTES.

1911 FROM THE BANKER'S POINT OF VIEW.—When presiding, last week, at the annual ordinary general meeting of the shareholders of the London County and Westminster Bank, Lord Goschen reviewed the year 1911 from the banker's point of view. While not devoid of a certain amount of anxiety, upon the whole it had not been an unfavourable period. The trade of the country had progressed satisfactorily, showing an increase both of exports and imports. Money rates had been favourable to trade, moving within narrower limits than in 1910. The situation abroad, during the summer and autumn of last year, had caused considerable anxiety to bankers, and the disturbed state of the political atmosphere had called for extreme caution in financing commitments abroad. In spite of these troubles, however, the bank had been able to do very satisfactory business during the year, and to declare a dividend of 21¼ per cent. Sir Edward Holden, also, was able to assure the shareholders of the London City and Midland Bank that, although it had been necessary to write off from reserve funds £200,000 to meet the depreciation in securities, the surplus profits for 1911 had been very satisfactory indeed, and more than sufficient to balance this depreciation.

THE PRODUCTION AND CONSUMPTION OF COAL IN INDIA.—A note on the production and consumption of coal in India has just been issued by the Commercial Intelligence Department in Calcutta, the leading feature of the returns being the remarkable and steady increase of production during the past thirty years. In 1880 the total out-turn of Indian coal was 1,019,793 tons, and in 1910 this had risen by progressive steps to 12,047,413 tons. The Raniganj field in Bengal held the first place as regards production up to 1905, but now stands second to Jhasia. Outside Bengal the most important mines are those at Singareni in Hyderabad. Twenty years ago the total consumption of foreign coal on the railways was about one-fourth of the whole, but since then Indian coal has come more largely into use, in so much that the foreign coal has been largely displaced, the Indian coal representing nearly 99 per cent. of the total consumption on the railways in 1910. So far as the statistics of India itself are concerned, the annual output above and below ground per person employed has increased from 93½ tons in 1905 to 103·8 in 1910; figures, however, it may be observed, considerably below the 264 tons of the United Kingdom, 246 of Germany, and 160 of Belgium. The Indian miner is still to some extent a miner by caprice, and in a year of agricultural prosperity the scarcity of labour becomes acute. Epidemics of cholera and other diseases are not infrequent, and cause a shortage of labour. As the workings get deeper the need of a mining population which specialises in mining will become

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greater. The use of electricity on the coalfields is extending, though capable of further utilisation, particularly for haulage and pumping, and the employment of mechanical coal-cutting appliances will be necessary where the seams are narrow and remote from the surface.

HOP-GROWING IN FRANCE. — The Minister of Agriculture has lately published the result of an inquiry that has been made concerning the hop-growing industry in France during 1911. From this it appears that although hops were grown in eleven departments, on a total area of 2,742 hectares (6,772 English acres), the cultivation of this plant is very unequally distributed amongst them, and may be considered as confined to four only, viz., Department Nord, 1,085 hectares (2,680 acres); Meurthe-et-Moselle, 522 hectares (1,287 acres); Côte d'Or, 942 hectares (2,327 acres); and Haute-Marne, 110 hectares (272 acres); making a total of 6,566 acres. The average yield per hectare was very variable in the various localities, and was from 1,200 kilos per hectare to 1,800 kilos (9 cwt. 63 lbs. to 14 cwt. 39 lbs.) in the Nord, which may be considered as good. In the Meurthe-et-Moselle districts the average was very low, not exceeding 400 kilos per hectare (3 cwt. 21 lbs. per acre). It was slightly better in the Department of Côte d'Or, being 636 kilos per hectare (5 cwt. 7 lbs. per acre). The quality of the hops produced last year in France is considered excellent.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 7.—LEONARD HILL, M.B., F.R.S., and MARTIN FLACK, M.A., M.B., B.Ch., "The Influence of Ozone in Ventilation." LORD SANDERSON, G.C.B., K.C.M.G., Chairman of the Council, will preside.

FEBRUARY 14.—CECIL THOMAS, "Gem Engraving." SIR ARTHUR JOHN EVANS, D.Litt., LL.D., F.R.S., will preside.

FEBRUARY 21.—FRANK WARNER, "Silk." SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

FEBRUARY 28.—H. A. ROBERTS, M.A., "The Relations of Science to Commerce and Industry." PRINCIPAL SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

FEBRUARY 8. — COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-Eastern Frontier of India." SIR FREDERIC W. R. FRYER, K.C.S.I., formerly Lieutenant-Governor of Burma, will preside.

MARCH 14.—E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

APRIL 25.—WALTER SAISE, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

MAY 16.—NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MAY 7.—ALAN BURGOYNE, M.P., "Colonial Vine Culture."

MAY 21.—THE HON. J. G. JENKINS, "Australian Railways."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." Three Lectures.

Syllabus.

LECTURE I.—FEBRUARY 5.—The Bullock and its Products.

LECTURE II.—FEBRUARY 12.—The Sheep and its Products.

LECTURE III.—FEBRUARY 19.—The Pig and its Products.

LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

JOHN NISBET, D.Oec., late Conservator of Forests, Burma, "The World's Decreasing Timber Supplies."

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

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CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

HAROLD COX, "The Interdependence of Morals and Economics."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

GEORGE FLETCHER, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Loudon M. Douglas, "The Meat Industry." (Lecture I.—The Bullock and its Products.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Presidential address by Mr. J. Kennedy.

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Discussion on "The Industrial Bursaries Scheme of the Commissioners of the 1851 Exhibition." 2. Mr. J. S. S. Brame, (*a*) "Constant Temperature Heating Apparatus for Explosives"; (*b*) "Experiments on the Decomposition of Nitro-Cellulose." 3. Messrs. W. P. Dreaper and J. G. Davis, "Some Physical Constants of Structureless Cellulose Filaments (Artificial Silk)."

British Architects, 9, Conduit-street, W., 8 p.m. Address by the President.

Victoria Institute, 1, Robert-street, Adelphi, W.C., 4.30 p.m. Rev. Professor James Orr, "The Historicity of the Mosaic Tabernacle."

London Institution, Finsbury-circus, E.C., 5 p.m. Professor A. F. Pollard, "The Evolution of England."

TUESDAY, FEBRUARY 6...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture IV.)

Alpine Club, 23, Savile-row, W., 8.30 p.m. Lecture by Dr. A. M. Kellas.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Mr. D. C. Leitch, "The Water-Supply of the Witwatersrand." 2. Mr. E. C. Bartlett, "Investigations Relating to the Yield of a Catchment-Area in Cape Colony."

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. C. E. Kenneth Mees and Mr. C. Welborne Piper, "On the Fogging Power of Developers. Part II. —Determination of the Solubility of Silver Bromide in Sodium Sulphite and other Solvents."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. H. G. Plimmer, "Report on the Deaths which occurred in the Zoological Gardens during 1911." 2. Mrs. R. Haig Thomas, "On Experimental Pheasant Breeding." 3. Mr. J. T. Cunningham, "Mendelian Experiments on Fowls." 4. Mr. J. Lewis Bonhote, "A Further Collection of Mammals from Egypt and Sinai." 5. Mr. H. Wallis Kew, "On the Pairing of Pseudo-scorpiones."

Horticultural, Vincent-square, Westminster, S.W., 3 p.m.

WEDNESDAY, FEBRUARY 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Drs. Leonard Hill and Martin Flack, "The Influence of Ozone in Ventilation."

Geological, Burlington House, W., 8 p.m.

Public Analysts, Burlington House, W., 8 p.m. 1. Annual General Meeting. 2. Messrs. F. W. F. Arnaud and H. Hawley, "Notes on the Determination of Butter Fat and Cocoanut Oil in Margarine." 3. Messrs. H. Droop Richmond and H. C. Huish, "The Souring of Milk." 4. Mr. E. Hinks, "A Flour Improver."

United Service Institution, Whitehall, S.W., 3 p.m. Lieut.-Colonel G. Le M. Gretton, "The Raising of the National Reserve in a Country District."

King's College, Strand, W.C., 5 p.m. (Lectures on Christian Art.) Miss Gertrude Bell, "The Christian Churches of Western Mesopotamia."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. J. A. Gotch, "The Original Drawings for the Palace of Whitehall, attributed to Inigo Jones."

THURSDAY, FEBRUARY 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Colonel Sir Thomas H. Holdich, "The North-Eastern Frontier of India."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Röntgen Society, at the Institution of Electrical Engineers, Victoria-embankment, 8.15 p.m.

Automobile Engineers, 13, Queen Anne's-gate, S.W., 8 p.m. (Graduates' Section.) Mr. B. W. Ainsworth, "Worm *versus* Bevel Drive."

London Institution, Finsbury-circus, E.C., 6 p.m. Mr. Josiah Booth, "Songs and Ballads of Sir Arthur Sullivan."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. M. Worthington, "The Phenomena of Splashes." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Rev. D. G. Cowan, "Gotland and its Ruins."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. E. H. Rayner, "High Voltage Tests and Energy Losses in Insulating Materials."

Mathematical, 22, Albemarle-street, W., 5.30 p.m.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Discussion on Professor Beresford Pite's paper, "The Aesthetic Treatment of Concrete."

Architects, Society of, 28, Bedford-square, W.C., 8 p.m. Mr. G. C. P. Monson, "Housing."

FRIDAY, FEBRUARY 9...Royal Institution, Albemarle-street, W., 9 p.m. Dr. J. A. Harker, "Very High Temperatures." (With electric furnace experiments.)

Medical Officers of Health, Society of, 1, Upper Montague-street, W.C., 5 p.m. Dr. G. A. Auden, "Open-air Schools."

British Foundrymens' Association (London District), Cannon-street Hotel, E.C., 8 p.m. Mr. J. Edwards, "Brasses."

Municipal and County Engineers, Caxton Hall, Westminster, S.W., 7.30 p.m. Discussion on paper by Mr. W. J. A. Butterfield, "The Relation of Modern Road Surfacing to Fish Life."

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Captain H. R. Sankey, "Steam Turbines: Some Practical Applications of Theory." (Lecture II.)

SATURDAY, FEBRUARY 10...Royal Institution, Albemarle-street, W., 3 p.m. Sir Alexander C. Mackenzie, "Franz Liszt (Centenary)." (With musical illustrations.)

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Journal of the Royal Society of Arts.

No. 3,090. VOL. LX.

FRIDAY, FEBRUARY 9, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 12th, 8 p.m. (Cantor Lecture.) LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." (Lecture II.)

WEDNESDAY, FEBRUARY 14th, 8 p.m. (Ordinary Meeting.) CECIL THOMAS, "Gem Engraving." SIR ARTHUR JOHN EVANS, D.Litt., LL.D., F.R.S., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, February 5th, MR. LOUDON M. DOUGLAS, F.R.S.E., delivered the first lecture of his course on "The Meat Industry."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, February 8th; SIR FREDERIC W. R. FRYER, K.C.S.I., formerly Lieutenant-Governor of Burma, in the chair. A paper on "The North-Eastern Frontier of India" was read by COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, January 30th, 1912. THE HON. SIR RICHARD SOLOMON, G.C.M.G., K.C.B., K.C.V.O., K.C., High Commissioner for the Union of South Africa, in the chair.

THE CHAIRMAN, in introducing the reader of the paper, said that the subject of irrigation was of very great interest and importance to those who were concerned in the development of the agricultural industry in South Africa. The author was fully competent to deal with that subject, because he was for many years attached as an engineer to the Irrigation Department in the Cape Province, which he knew from beginning to end; he fully appreciated from practical experience the great advantage of irrigation to the cultivators of land in South Africa, and he also appreciated the great difficulties which people who went in for irrigation works in South Africa had to contend with.

The paper read was—

IRRIGATION IN SOUTH AFRICA.

By W. A. LEGG, M.Inst.C.E.

INTRODUCTION.

The new Union of South Africa contains some 473,000 square miles, with a population of about one and a quarter million Europeans and four and three-quarter millions coloured. In the year 1910 there was imported into the country over sea, agricultural produce, including grain, flour and meal, meat, milk, butter and cheese, etc., of the value of over three million pounds sterling.

What is the reason that after 250 years of occupation by Europeans so vast a country is still unable to supply sufficient food for its inhabitants, whose density all told is under thirteen persons per square mile, whilst that of the white people who are, after all, those for whom imports are chiefly made, is under three persons per square mile?

No one cause will fully account for this; it is contributed to by many, and the history of the country affords some explanation of the slow progress made. Of the four colonies included in the Union, the Cape is the only one

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which, previous to the middle of the nineteenth century, enjoyed for any considerable period the peace so necessary to agricultural development—and that only in the western province. Fighting with the natives upon the eastern and northern borders was in constant progress. Skirmishing with, and driving off, thieving and marauding bands developed occasionally into organised punitive expeditions, and kept the settlers constantly on the *qui vive.*

Internal political difficulties added cause for disquiet, and on more than one occasion threatened serious civil strife. All these things were against the agricultural development of the country, and caused the farmers in the east frequently to abandon lands which they had taken up and partly reclaimed, and to trek to new parts. The history of the occupation of the Orange Free State and the Transvaal is one of a people trekking to avoid dangers and uncongenial surroundings, rather than of a people marching to possess a land of promise, and the wonder is not that so little progress was made, but rather that the early settlers had the courage to persevere against such adverse circumstances.

Hindrances to Progress.

About 1875 troubles with the natives may be said to have ceased, and from that time amongst the causes militating against progress the following were, perhaps, the most potent:—

1. The distribution of the white population, which was so thinly scattered throughout the country as to prevent or render difficult intercourse and mutual action for advance.
2. Adverse climatic conditions.
3. Difficulties of transport.
4. Legal difficulties.

The lack of intercourse with their fellows produced a general apathy amongst a large section of the farming population—the Boers. They lived in a condition of isolation, such as the inhabitants of civilised and closely populated countries can hardly realise, and to the dwellers in the back veld the traditions of their forefathers had become the only rules of life. Here was no new thought, no progress. For generations they had been a pastoral people, undertaking only such cultivation of the ground as was necessary for their own immediate wants, which, indeed, were few. They knew the rainfall to be scanty, and were accustomed to periodic droughts, when even their natural pasturage was burned up, and ceased to afford feed for their flocks, which often perished in large numbers in consequence. The river courses they found through the greater portion of the year as dry as the remainder of the country, and when water did flow it was generally only for a few days at a time; so that if they were able to preserve sufficient water for their stock it seemed as much as could reasonably be hoped for. Thus they remained a pastoral people.

Difficulties of transport were so great that if a farmer was fortunate enough to have water on his farm which might be of use for irrigation, unless he was within reasonable distance of a railway, he was generally faced with an almost impossible task in getting to a suitable market any crops which he might produce. It must be remembered that the railways are of comparatively recent origin. Of the 6,000 odd miles now open, there existed in 1875 only a few short lines from the coast, not exceeding about 150 miles in all.

The trunk lines of the country have been constructed for the exploiting of its mineral wealth, and only in consequence of that wealth have they now traversed so great an extent. Of later years branch lines have been built, and greater facilities extended to the agricultural population, but there is still much to be done in order to open up the country. There appears to be an opportunity to apply motor vehicles, running upon the roads, to feed the railways, and such a system, if initiated, might do much to encourage agricultural activity. The whole population is small, and large centres, where alone considerable markets for farm produce exist, are generally far removed from the best lands; also, in many cases transport by sea will bring food at much cheaper rates than it could be delivered at by the railways from the interior, so that clearly the farmer is not much encouraged to supply these markets until some better transport facilities exist.

The last cause which was named against development of irrigation was legal difficulties. The state of the law was not by any means calculated to promote the practice where the possibility existed, and attempts at irrigation were productive of much litigation, which could not but discourage its extension.

With all these adverse conditions it is not very surprising that the country remained almost entirely a pastoral one, though even in that capacity it left much to be desired. The natural veld, which provides practically the whole of the pasturage, may at its best carry one sheep to three or four acres, but owing to climatic conditions it very seldom is at its best, and

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the number of sheep which it will carry varies from the figure given to zero.

In the early days of the white occupation there were large areas of country unoccupied, and farmers were in the habit, when their own veld became poor, of trekking away with their flocks to fresh pastures, and of returning to their own when it had become refreshed by rain and rest. As, however, land became more taken up it became increasingly difficult to find fresh veld, and hence in times of drought flocks must either be fed artificially or perish. There is no doubt also that when first occupied by Europeans much of the country—practically all the valley bottoms—was in much better condition of pasture than it is to-day. The present deep-river channels did not exist, and the valleys were rich vlei land covered with luxuriant vegetation. This change which has taken place will be referred to again later; it has been very harmful to the country, and must have reduced its stock-carrying capacity enormously. The recognition of these facts serves to indicate one direction, at any rate, in which irrigation may for a long time to come be very profitably directed—viz., to improving the natural pasturage, restoring the valleys to their earlier vlei condition, and growing forage crops for flocks and herds. This would not only provide against the dangers of drought, but would tend to increase the stock-carrying capacity of the country. It would also at once remove that most powerful deterrent to crop production—viz., the difficulty of transport, for crops fed to cattle can very readily be transported to market.

Crops without Irrigation.

The growing of crops on the rainfall alone, without artificial watering, can only be attempted in some of the more favoured portions of the country, and these collectively do not form a large proportion of the whole.

The simplest crops, and those which would naturally be first tried by a pioneer farmer, would be the commoner cereals—wheat, oats, and barley. These crops do not require a large amount of water, but are rather particular as to when they receive it. A good wetting of the land is necessary before ploughing can be accomplished, and again during the growing period at least one good watering is required.

Wheat is generally sown some time between May and August, and that and its growing time are the dry season over most of the country; therefore it is generally imperative that the soil should have been thoroughly wetted before sowing. If that has not happened it is useless to sow, and as it rarely happens in South Africa —except in special localities—so the growing of cereals on the rainfall is rare also.

The south-western portion of the Cape Colony, and what is known as the conquered territory in the Orange River Colony, are almost the only large areas where wheat-growing on the rainfall is carried on. The former is particularly favoured by nature for the purpose, as it has a good rainfall averaging 18 ins. to 20 ins. per annum, and receives the greater portion of it during the sowing and growing season of wheat.

An area of some 7,000 square miles lying around Malmesbury, produces annually quite half of all the wheat grown in the Cape Colony. In 1904 this district produced about 850,000 bushels out of a total of 1,685,000 bushels grown. These figures are taken from the census returns of 1904, and are the last reliable figures published. The Orange River Colony is able to produce wheat on the rainfall along the valley of the Caledon River, but the Transvaal grows practically none. Besides wheat, mealies are almost the only other crop grown on the rainfall. They are produced in the Transvaal, Orange River Colony, and Natal, in quantities increasing yearly, and are a summer crop requiring most moisture in December, January, and February, a condition which exactly suits the climate. There are those who expect to see the export of mealies develop into a large trade. On the European market, however, there are many competitors who will assist in keeping the profits at a low figure.

Another area which has for long produced wheat of excellent quality, and in quantity increasing year by year, is the valley of the Zak River in the north-west of the Cape Colony, but there it is not grown on the rainfall, which is extremely scanty, but on a system of flood-irrigation to which further reference will be made later.

Outside of the favoured areas referred to, it has not yet been found practicable to produce, with any certainty, crops on the rainfall only. That this will be materially altered in the near future is very probable. Experiments in dry farming are in progress, undertaken by both the State and individual farmers, which go to show that very successful results may be accomplished, and lands which have hitherto been classed as arid and unproductive, will doubtless be made to yield crops of cereals, grasses, and even lucerne. The further discussion of this subject, however, deeply interesting though it is, is outside the scope of this paper.

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Rainfall.

It may at this stage be useful to remark briefly on the rainfall of the country, as it has a very important bearing on irrigation, and the possibilities of its development.

The rainfall varies from $2\frac{1}{2}$ ins. per annum, or less, in the north-west of the Cape Colony, to between 40 ins. and 50 ins. on the coastal regions of Natal, with still heavier precipitation at a few local centres, notably in the south-west of the Cape Colony, where, upon a small area extending from Cape Town to Ceres, rainfalls up to 80 ins. per annum are registered in the mountains.

Very heavy rainfalls are also experienced in the mountains of Natal. Over the whole country the rainfall is generally least on the western side, and increases steadily towards the east.

In the Transvaal, the Orange River Colony, and the north and east of the Cape Colony, the rain falls chiefly in the summer months, and only the south-west of the Cape Colony is subject to winter rains.

Along the south coast the rain is fairly evenly distributed throughout the year. A meteorological commission has existed for many years in the Cape Colony, and has collected a very valuable record of rainfall from some 450 stations distributed over the whole country.

In the other States, records have not been kept so systematically, but during recent years steps have been taken to correct this, and the Transvaal has now a greater number of gauges in proportion to its area than the other States, and will probably before long have actually a greater number than any other State. The Orange River Colony has also moved in the same direction during the past few years. The records show that in most parts of the country the rainfall is generally fairly regular. It must be noted, however, that occasional extremes both of wet and drought are experienced. Looking through the records for the decade 1898–1908, rainfalls of from 3 ins. to $4\frac{1}{2}$ ins. in twenty-four hours are found at places scattered throughout the length and breadth of the Karoo and Orange River Colony. In the Transvaal, falls of from 5 ins. to $11\frac{1}{2}$ ins. in twenty-four hours are recorded in most districts to the east of 28° Greenwich longitude; whilst along the south coast districts falls varying from 5 ins. to $16\frac{1}{2}$ ins. in twenty-four hours have been measured.

On the other extreme, we have many instances throughout the Karoo of total rainfall for twelve months amounting to less than 4 ins., and there are several gauges which have received absolutely no rain for a period of twelve months.

A knowledge of this possibility of extremes is of immense importance to the engineer designing irrigation works. The possibility of droughts, warns him of the necessity to provide storage, and the possibility of floods, of the necessity to make sufficient provision of spillways to insure the safety of his works.

The mean annual rainfall of the Cape Colony is about 15 ins., that of the Transvaal about 29 ins., of the Orange River Colony 21 ins., and of Natal about 34 ins. The mean for the whole of the Union is probably about 20 ins. per annum.

The heaviest rains occur in the mountain districts and on the eastern side of the country, and it is safe to say that there is very little of the best soil of the Karoo which receives sufficient rain to remove it from the unenviable category of arid lands, or to offer much inducement to attempt cultivation on the rainfall only.

Moreover, small as the rainfall is, and although the greater portion of it falls in the wet season—which is the summer—it is generally distributed throughout the whole year, so that in a year of small total rainfall, individual rains are usually so small as to be of little or no service. As an illustration of Karoo rainfall, the following figures, based upon twenty-eight years' records taken at Hanover, may be of interest. Observations have been made for over thirty years, but unfortunately those for the two years 1892–3, are incomplete, so have been omitted from the analysis.

The table gives for each month the mean total rainfall, the number of days on which rain fell, and the average amount for each of those days.

Month.	Mean Total Rain for Month in inches.	Number of Rain Days.	Average Fall per Rain Day in inches.
January	1·72	5	·34
February	2·04	6	·34
March	2·38	6·1	·39
April	1·56	4·5	·35
May	1·11	3·5	·32
June	·50	2	·25
July	·43	1·5	·29
August	·36	1·3	·27
September	·72	2·5	·29
October	·83	3	·28
November	·92	3	·31
December	1·18	3·6	·33
Totals for year	13·75	42	·32

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The mean total annual rainfall is 13·75 ins. It will be seen that the wet and dry seasons are well marked. Dividing the year into two periods of six months each, we find that about 75 per cent. of the total rain falls in the period including the months December to May, and only 25 per cent. in the other six months. We see that the wettest month is March, with a mean of 2·38 ins. This is not a heavy month's rainfall, and its distribution decreases its possible utility. Thus the average number of days in March on which rain fell is 6·1, so that the average amount which fell on each rain day was only ·39 in. These remarks apply *mutatis mutandis* to the other months of the rainy season, and the figures for mean rainfall per day on which rain fell are remarkable for their regularity. During the six wet months they vary only from ·32 in. to ·39 in., and during the dry season from ·25 in. to ·31 in. per day, the average for the year being ·32 in.

The years of minimum and maximum rainfall, *viz.*, 1903 with 1·74 ins., and 1891 with 25·75 ins., are both remarkable, the former having only 13 per cent. and the latter almost double of the mean. During the minimum year the average rainfall on the days on which rain fell was ·08 in., and the maximum fall on any day was ·40 in., whilst during the maximum year the figures were ·41 in. and 2·95 ins. respectively. The fact of the wet season being in the summer is against the growing of cereals, which are usually sown from May to August, and though suited to the maize season the rainfall is hardly sufficient for the production of that crop. The rainfall at Malmesbury is not so very different from that of Hanover in quantity, but the bulk of it falls during the growing season of cereals. Thus, whilst Malmesbury, out of a mean total annual rainfall of 18·23 ins., receives nearly 14 ins. during the six months April to September, Hanover has only 4·68 ins. during the same period out of its total of 13·75 ins. During the driest year on record, Malmesbury received during the six months named, 7·28 ins., whilst Hanover had only ·62 in. in its driest year.

Run-off.

Very little reliable information is as yet available regarding the proportion of run-off to rainfall. It is one of the questions engaging the attention of the Irrigation Department. There is no doubt that the percentage has a wide range throughout the country, attaining a maximum on the mountains which lie within zones of high rainfall, and a minimum on the plains within zones of low rainfall. The run-off from any area will vary for different times and seasons, being generally highest in the rainy season and lowest in the dry. It will be influenced by many factors, *e.g.*, the amount and intensity of rainfall, the temperature, condition of the ground immediately preceding rain, etc. Of any single factor the *amount* of rain will probably have the greatest influence, and the amount combined with intensity will always show a dominating influence.

It is extremely difficult to obtain reliable run-off results, for even small catchment areas, chiefly owing to the difficulty of obtaining an accurate mean rainfall on the area, and on large catchments the possible local variations render it more difficult still. The Cape Colony is the only State of the Union where observations have been continued long enough to permit even rough approximations to be made, and the author is of opinion that 5 per cent. of the rainfall may safely be assumed to flow off as a mean for the whole Colony. Such results as have been obtained in the Transvaal go to show that, at any rate for the area draining to the Atlantic Ocean, a smaller result would have to be assumed, and the same would probably apply to the Orange River Colony. The heavier run-off from the mountain districts benefits the country by providing water for irrigation. Attempts have been made to estimate the quantity of water flowing annually to the sea, and though the results must of necessity be only approximate, they form some basis on which to estimate the possibility of irrigation. While the proportion of water utilised is only a small fraction of the total quantity, the figures are useful, and should the time come when a large proportion is being utilised, it will be necessary to revise the estimate, and no doubt by that time the data available will simplify the task.

The author has estimated that in the Cape Colony the total mean annual amount of water precipitated as rain over the whole surface is about 218,000,000 acre feet, and that at least 5 per cent. of this flows off to the sea. Assuming that four acre feet per annum flowing in the river channels would irrigate one acre, which is a liberal allowance, we find that there is sufficient water flowing to waste for the irrigation of about 2,700,000 acres. Although it is not known at present what area of irrigable land is in the Colony, a general knowledge of the country gives one confidence in saying that there is certainly not less than the above-named area which would be well worth irrigating, so that there is every probability that a good use could be found for all the available water. The last census return of 1904 gives the total area irrigated in the Cape

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Colony as about 400,000 acres. During the past few years considerable activity has been shown, and probably 100,000 acres additional might now be estimated as irrigated, or likely to be so in the near future, so that we may assume at least 500,000 acres now under irrigation. This would leave at least two million acres in the Cape Colony which it is possible might be brought under water. Good land under irrigation could hardly be worth less than £10 per acre, whilst the best might be worth £100, so that here is seen a prospective increase of wealth to the country well worth some pains to procure. Of the other States of the Union, sufficient data are not yet available to enable estimates to be made. In the Transvaal there is said to be about 100,000 acres now under irrigation, chiefly from perennial streams.

There is plenty of scope for irrigation extension in both the Transvaal and Orange Free State, but the problem is somewhat different from that in the Cape Colony. To begin with, there is a better rainfall, and when the rivers are in flood the riparian lands have generally benefited by the rain, which raised the rivers, and so do not require further irrigation. That characteristic of the Karoo, viz., of the rivers coming down in flood with little or no rain upon the irrigable lands, does not apply. Therefore, in the northern States storage will be more generally necessary as part of any irrigation scheme not on perennial water.

Law Relating to Irrigation.

It may be well now to consider briefly the remaining condition which has in the past influenced greatly irrigation development—viz., the law governing the rights to, and use of, water. We shall then look generally at what has been done in the way of irrigation in the past, and at what are the possibilities of the future. In a country where water is scarce and valuable, the law regarding its ownership and use must of necessity exert a great influence upon the extent to which irrigation will be practised. In the early days of the country's history, water disputes were heard by boards of Landdrost, but in 1827 these were abolished, and such cases were afterwards heard by the Supreme and Circuit Courts. There was no statute law on the subject. From 1861 onward, several attempts were made by the Parliaments of the Cape Colony to legislate on this subject, but it was not until 1876 that any result was achieved. In that year an Act was passed, entitled the Right of Passage of Water Act, to enable persons having right to water to convey it across the land of other persons, but the Act proved of little practical use.

In 1877 the first Irrigation Act was passed, which made provision for the establishment of irrigation boards and districts, and for grants of Government loans to such boards or to private individuals for the construction of irrigation works. The price charged for such loans was 8 per cent.; 6 per cent. as interest, and 2 per cent. for amortisation to extinguish the debt in twenty-four years. In 1879 the Act was amended to allow municipalities also to borrow money for irrigation works under the same conditions.

In 1880 the Act was further amended to allow of the advance of one-fifth of the total amount of a loan before the commencement of the works, instead of allowing payments only on the value of work executed. The new Act also provided for the redemption of the loan in a less period at the option of the borrower, with the consent of the Minister of Public Works, the sinking fund varying according to the period. The municipalities appear to have been the only persons to make use of these Acts so far as borrowing was concerned.

In 1893 a short Act was passed allowing private individuals to borrow on the same terms as boards. In 1897 an Act was passed reducing the rate of interest charged on loans to 3½ per cent. plus an amortisation payment necessary to extinguish the debt in such number of years as the Minister might approve, not exceeding forty.

In 1899 was passed the Water Act, which provided for the appointment of Water Courts for hearing disputes connected with the use or appropriation of water, for hearing applications from riparian owners entitled to divert water from public streams for permission to take it at some point upon the land of another owner, to apportion the flow of a perennial stream between several owners on the application of one or more of them, and to prescribe the mode of such division. The Water Court could deal only with cases where there was not already any registered prescriptive rights, and its judgment was subject to appeal to the Supreme Court in case any person affected was dissatisfied.

Water Courts under this Act were established only as the necessity arose—*i.e.*, when some owner desired to bring a case up. There was always the Supreme Court, and the case could only go to the Water Court by consent of all parties. Very few Water Courts were actually established under the Act, but such as were appear to have acted very satisfactorily.

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The statute at present in force is the Irrigation Act of 1906, based upon the earlier Acts, all of which it repealed. This Act gives original jurisdiction to the Water Courts in cases of water disputes which can only be first heard in the Supreme Court by consent of all parties (in this respect it is the exact converse of the Act of 1899), except in cases where the disputes arise regarding rights obtained by the judgment of a superior court, the award of an arbitrator, or as a condition of grant or transfer.

Besides retaining the Water Courts of the earlier Acts with increased powers, and the Irrigation Boards, provision is made for the constitution of river boards and districts.

The river board is to exercise a general supervision over streams in its district, with power to cleanse, widen and otherwise improve them; to prevent unlawful diversion of water, to record the flow of the streams, prepare maps of the district, collect hydrographic data, and generally to take steps to increase the utility and use of the water in the district. The Board may supervise the distribution of water according to established rights, but has no power to create rights; and it may levy rates—called river rates—to defray expenses incurred. Appeals against acts or orders of the river board may be made to a Water Court or other competent court. An irrigation board is usually appointed for the purpose of constructing and managing a specific scheme of irrigation in the interest of two or more owners of property co-operating in a joint work. Thus there might be several irrigation boards within one river district, and several river boards within one Water Court district. Both river and irrigation boards are elected by the owners of property in the districts from amongst their number, but the Water Courts are composed of a resident magistrate having jurisdiction in the district (who will act as chairman), and two assessors selected from a list of Water Court assessors approved by the Governor after consultation with the divisional council of the district. Such assessors must be owners and occupiers of land in the district. The selection of the two assessors to hear any particular case is by lot. Any of the parties to the case may object to an assessor on certain grounds named in the regulations, and the magistrate shall decide whether or not the objection shall be allowed. If allowed, a new drawing of names takes place.

The Irrigation Act of 1906 introduces some considerable alterations into the law relating to water rights as it previously stood. It legislates for intermittent streams, as well as for perennial ones. This was, indeed, one of the chief objects of the Act. It takes away the absolute ownership in an intermittent stream from the person on whose land it flows, which, under the common law, he enjoyed, and prevents him from leading away the water of such stream for use on non-riparian lands, except by permit from the Water Court, which permit, however, shall apply only to surplus water. It also allows prescriptive rights in the water to a lower owner on to whose land some of the water has flowed for a period of thirty years, which right he could not previously claim under the common law. The Act further makes provision for the diversion of the surplus water of a perennial stream across a watershed. Thus, whilst curtailing to some extent the use of the intermittent stream, the Act extends the use of the perennial water. It gives to the Government, and to some extent to river and irrigation boards, the power to expropriate land for irrigation purposes on payment of compensation to the owners, allows boards and individuals to claim servitudes or easements on the land of others, and makes provision for the granting of Government loans to boards or individuals for irrigation purposes.

In 1908 regulations were proclaimed under the Act, which have equal force with the Act itself. Under the Irrigation Act of 1906, Water Courts have been established over the whole of the Cape Colony, which for the purpose has been divided into sixty-five districts, the boundaries of which correspond more or less with those of the fiscal districts.

In 1908 an Irrigation Act was passed in the Transvaal, framed on the lines of that of the Cape Colony, and no doubt it will be an early care of Parliament to prepare a uniform Act for the whole Union.

Natural Herbage.

The surface of the country included in the Union lies generally at a high altitude, almost the whole of the cultivated lands, with the exception of a strip along the coast, lying at from 2,000 ft. to 6,500 ft. above sea-level.

In the Cape Colony the natural herbage of the veld consists of varieties of short bush—many of them aromatic—which provide excellent pasture for sheep, goats, cattle and ostriches; excellent, that is to say, as to quality, though its quantity, owing to lack of moisture, is often less than desirable. In the Orange River Colony and the Transvaal the veld is generally covered with grasses, some of which afford good pasture, while others are more or less poisonous.

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A good deal is now being done in all parts of the country in the way of introducing better classes of grass, and the experiment promises good results.

Early Irrigation.

As might be expected, the earliest efforts at irrigation were with the waters of perennial streams, where the water could be utilised by means of a simple weir to turn it out of the stream channel and a canal or furrow to convey it to the land. Such method has been practised in parts of the country for many years, and there is still to be seen a furrow leading from the Breede River in the Cape Colony which is said to have been constructed over eighty years ago. The Oudtshoorn district has always taken the lead in this class of irrigation, being favoured with a perennial stream flowing through very fertile lands, which have been worked to great advantage. This district has for many years led the way in ostrich farming, in which lucerne cultivation under irrigation has been a prominent feature, but of late years this has also been taken up in a spirited way in the eastern province, and is now extending gradually throughout the whole country. The growth of this important industry is shown by the following figures:—

In 1865	there	were	about	80	tame ostriches in the country.
,, 1875	,,	,,	,,	21,750	,, ,,
,, 1891	,,	,,	,,	154,880	,, ,,
,, 1904	,,	,,	,,	357,970	,, ,,
,, 1910	,,	,,	,,	500,000	,, ,,

In 1908 nearly 800,000 lbs. weight of feathers were shipped from Cape ports, valued at over £2,000,000. Ostrich farming has long been a most remunerative industry, and its development has done much to promote irrigation, particularly by fostering and increasing the growing of lucerne. It is not to be expected, however, that the rapid expansion shown by the figures given above can continue, and we shall probably see a marked change during the next few years. Fortunately, the capital laid out in lucerne lands will not be lost, for when the time comes that the feather industry cannot profitably be extended, the fattening of cattle upon the lucerne will offer a most valuable field only second to that of ostrich farming. The danger to be avoided is that of capitalising the land on the too high returns obtained from the ostrich industry, which might handicap any less profitable one.

In addition to lucerne, tobacco, fruits, and vegetables have been cultivated under perennial irrigation.

The early irrigation which developed along the perennial streams was entirely due to individual effort, and, as already stated, has been abundantly attended and doubtless much retarded, by litigation. Flood irrigation with the waters of intermittent streams has also been practised for years to a limited extent, chiefly for the improvement of the veld. Many of the intermittent streams of the country, certainly the most important of them which traverse the Karoo, have very deep channels, often 30 ft. and more below the surface of the adjoining land, which renders irrigation from them somewhat difficult. In the early days of the white occupation these channels in all probability did not exist, and rain falling on the land spread itself over the surface of the plains, where it was to a great extent absorbed by the soil, very little water flowing away to the sea. As a consequence the plains were generally in great part vlei, covered with luxuriant vegetation, which provided food and cover for all manner of game. Within recent times this condition has changed. River channels have formed, cutting through the deep alluvial soil down to the bed-rock, by which the rain-water flows quickly away to the sea, carrying with it the easily denuded fertile silt of which the plains are formed, whilst in times of drought the channels tend to drain away all subsoil water and reduce the land to a parched and desert condition. This change has been brought about partly by the tramping of stock too thickly herded together first forming a course for the water, which afterwards developed into a deep channel. The burning of the vegetation, and the construction of roads and railways have also no doubt contributed to the result, the former by producing a more rapid discharge of the rain, and the latter by collecting the discharge and forcing it to follow defined channels. To restore the land to its former condition and prevent the sluiting of the soil and consequent rapid discharge of rain to the sea, would mean untold wealth to the country; and although this would take time, and necessitate considerable expenditure, yet it is not beyond the scope of practical politics.

In spite of the difficulties offered by the deep-river channels, where conditions were favourable for turning out the water upon fertile lands, advantage has been taken by the more enterprising farmers to improve the veld by flood irrigation, and at times to utilise the water for the cultivation of lucerne and other crops.

The early irrigation works were generally constructed in a simple manner. Weirs were of

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masonry, concrete, or stone and wire, according to local conditions. The last named is simple and, when well built, effective. It consists of stone, usually boulders collected in or about the river-bed, built into the required form and enclosed within a wire netting, which prevents the displacement of the stones. Sometimes the wire netting is made first and laid down on the river-bed. The dry-stone weir is then built upon it, and the loose edges of the net drawn over the top and fastened together, thus completely enclosing the stonework. Another method of building this form of weir is to lay down on the river-bed single wires, representing the warp of the net, and to work in the weft, and enclose the stonework as it is built up. The former method gives generally neater work, but perhaps costs rather more than the latter. The wire used is strong galvanised fencing wire. Such weirs are very effective to heights of 5 ft. or 6 ft., particularly on rivers which carry much silt, the silt quickly filling the interstices of the stones and rendering the work watertight.

Zaai Dam Irrigation.

An interesting method of flood irrigation, already casually referred to, is practised in the north-west of the Cape Colony, particularly along the valley of the Zak River. It is called "Zaai dam irrigation," and has been compared to the Basin method of irrigation in the Nile Valley, on a small scale. The Zak and Fish Rivers take their rise in the Nieuwveld mountains to the west of Beaufort West, and drain a very large extent of country. Above Kenhardt the catchment area is about 17,500 square miles, and above Brand Vlei about 15,000 square miles. At one time the Zak River must have been nothing but a succession of vleis for at least 100 miles of its course, where all the rainfall, except the largest floods, was retained. Now, however, there is a channel 15 ft. to 20 ft. deep, and up to 100 ft. or so wide, cut through the fine, rich alluvial deposit. For the greater portion of the year the channel is absolutely dry, and it has so drained the riparian lands that they are now arid and desert. The river usually flows once or twice during the summer season, sometimes oftener, owing to rains upon the upper portion of the catchment area, but in consequence of the rapid discharge effected by the deep channel, flow ceases almost as soon as the rain stops, so that the aggregate of flow for the year will generally not exceed a few days. And so deep is the channel now below the surface that it is only in exceptionally heavy floods that the river overspills its banks naturally, and wets the land. In order to bring this about more readily, and with smaller floods, weirs, usually made of earth and of quite a temporary nature, are thrown across the channel, which raise the water over the banks, whence it spreads over the land. The spreading of the water is aided by the rather curious circumstance that the land often falls away from the river banks, as shown in Fig. 1, which is a cross-section at right angles to the river channel. This condition

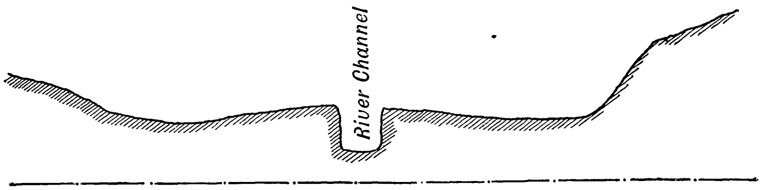

Fig. 1.

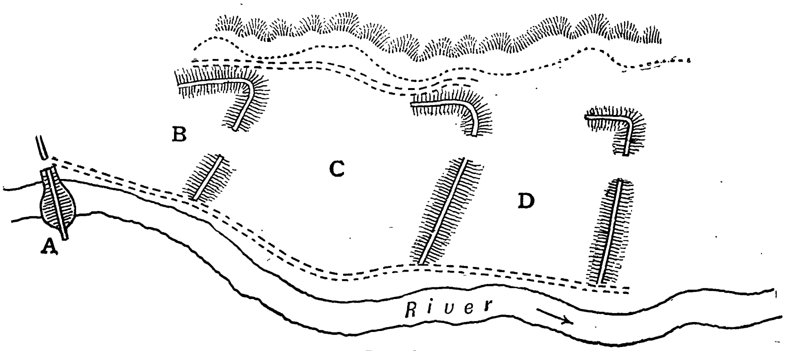

Fig. 2.

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is brought about by the fact that the river more often floods the land near to its banks than that more remote, and as each flooding means a deposit of silt, with which the water is always fully laden, the lands adjacent to the river oftener receive deposits, and so gradually rise to the higher level.

The water, having been turned out of the river channel by the weir, is held on the land by low earth embankments of a few feet in height, arranged as shown in sketch (Fig. 2). A shows the temporary weir across the river; B, C and D are Zaai dams, which may be flooded by passing the water down from one to another by means of temporary gaps cut in the embankments, or they may be fed by a furrow cut either along the river bank or at the foot of the koppies which bound the valley, as shown in dotted lines in the sketch; or the dams may be so made that the water is thrown over against the foot of the koppies and flows between them and the ends of dams remote from the river, filling each dam in turn without any furrow. Whichever way they are filled, the water is held in the dams as long as is considered necessary in order to soak the ground thoroughly, or if the water comes rather early in the season it may be held until sowing time approaches. The water remaining is then allowed to drain away, and the area which was submerged is ploughed and sown with wheat, which will mature and yield a good crop without further watering.

The weir A may be destroyed each season, but the Zaai dams would probably serve for a good many seasons. These dams are usually made with scrapers drawn by oxen, which give very cheap work. Owing to the flatness of the land a small amount of earthwork will generally serve to flood extensive areas, and a single Zaai dam may be of any size, from two or three acres up to a square mile or more. Although this method is as yet confined almost entirely to the Zak River, it is being copied in other parts, and there are many districts where it, or some modification, could be followed with advantage.

Sowing usually takes place between May and August, and reaping about the end of November or early in December, but crops are sometimes sown as late as December. Thirty-fold is considered a fair average crop, though higher returns are often got, particularly if a second watering should be obtainable. The seed is sown rather thinly (about 25 to 30 lbs. per acre), owing to the richness of the soil and consequent stooling of the plants. The writer has counted over eighty stalks on one root. Thirty-fold would therefore mean about 3½ to 4 bags per acre reaped.

Boreholes.

Added to these methods of irrigation was that from boreholes and wells. From about 1884 until 1908 the Government of the Cape Colony did a large amount of boring for water in the north-western districts of the Colony and Bechuanaland, assisting farmers financially on the pound for pound principle. During that period the Government's share of expenditure amounted to about £450,000, as a result of which some 5,600 boreholes were put down, which, in the aggregate, yielded about 18½ million gallons per day of flowing water, in addition to an estimated 35½ million gallons available by pumping, or a total of 54 million gallons per day. Although the work cannot be said to have been done cheaply, it has been of immense value to the country, particularly to stock-farmers. The boreholes are mostly rather shallow. The average depth of the whole 5,600 would probably be under 100 ft. each. In addition to the boreholes put down by the Government there were many others done entirely by private enterprise, so that there are probably not less than between 8,000 and 9,000 now in existence throughout the Cape Colony. Where pumping is necessary it is usually done by windmills, though some oil-engines are also used.

In 1904, boring operations were also commenced in the Transvaal, and the Government has now transferred its attention almost entirely to that State.

In 1908 the Government subsidy was discontinued in the Cape Colony, the necessity for it having, to a great extent, disappeared, owing to the work of boring having been taken up by private firms at cheaper rates.

The majority of the boreholes were not put down for the purpose of irrigation, but primarily for the watering of stock; nevertheless, a good deal of the water over and above that used for the latter purpose is applied to irrigation, chiefly to patches of a few acres in extent in the neighbourhood of the homesteads.

Small reservoirs with earthen dams—known as farmers' dams—are numerous throughout the country. Most of them have been constructed to provide water for cattle, but many contribute also for irrigation on a small scale. They are usually built in hollow places, where the drainage from small catchments can be caught in times of rain, and generally avoid stream courses from large catchments. The dams seldom exceed 10 to 12 feet at the highest part.

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The following figures give some idea of the progress of irrigation during the fifteen years preceding the passing of the Irrigation Act of 1906.

	Area Irrigated, in Acres.	
	In 1891.	In 1906.
From small dams, wells, boreholes, etc.	48,000	50,000
From perennial streams .	192,000	230,000
From intermittent streams	69,000	140,000
Total area . . .	309,000	420,000

RECENT IRRIGATION DEVELOPMENT.

Since the passing of the Irrigation Act, there has been considerable activity, and there is probably now at least 500,000 acres under irrigation in the Cape Colony alone. No doubt this is partly due to the improved conditions under the new law, but it is probably quite as much due to the more sympathetic attitude of the Government and the beneficial influence of the Irrigation Department. This department is now emancipated from the Public Works Department, of which it once formed a branch, and is freer to take a more practical and businesslike interest in the development of irrigation than it was in the past.

It has afforded much assistance to farmers, through its technical officers advising as to engineering details of schemes and as to financial results to be expected.

A good many works have been carried out in this way, varying in size from the small scheme to irrigate 20 or 30 acres to the more ambitious one dealing with several thousand acres. One of the largest, if not the largest, works of the kind in the country is now being constructed by the Smartt Syndicate on their farms in the Britstown district. The works will include a storage reservoir on the Ongers River, with a capacity of over 3,000 million cubic feet.

The dam will be the highest earthen dam in the country (about 60 ft. above the river-bed), and is made entirely of the silty alluvial earth of the district. The greatest care has been taken in the making of the dam, and much interest attaches to the result of constructing so high a dam with this class of earth.

For storage dams the earthen embankment is almost the only structure employed. Masonry or concrete dams have been built in several places, but always either for domestic supply only, or for that and irrigation combined, where the irrigation has been looked to to assist the municipal revenue. So far as the writer is aware, the only masonry dam in the country built entirely for irrigation purposes is on a settlement scheme in the Orange River Colony being carried out by the Government. Unless a site is very greatly favoured by nature, the masonry dam must prove too expensive for irrigation.

The earth generally used for the construction of earthen dams is not such as would appeal to European engineers for the purpose. There is little real clay in the country, and the alluvial ground used is usually light silty loam. For low dams it has, with careful construction, answered well, but its suitability for high dams has yet to be proved. In the smaller dams it is not usual to introduce puddle cores; indeed, suitable material would not often be available, and the best that can be done is to select the best of the material for the centre portion or the water side of the dam.

Reinforced concrete has been used in the construction of aqueducts and siphons. Imported materials of construction such as cement, ironwork, etc., are usually expensive up country, owing to cost of transport, but otherwise prices for work are not much in excess of European prices. Native labour is employed for all except skilled work, the rate of pay being from 2*s.* to 3*s.* per day.

The Government has, under the Act of 1906, advanced a considerable amount in loans for the construction of works. One of the most interesting features in the working of the Act is the number of irrigation boards which have come into existence and taken advantage of the Government loan system. Previous to the passing of the Act there were only three such boards, all of them in the Breede River valley, and working with perennial water. Two of these may be said to have been formed whilst the Act was under consideration, though the other had existed since 1904. Between 1906 and 1910 seven other boards were established, and all have works now in course of construction under Government loans, which will irrigate in the aggregate about 24,000 acres, at a cost of £110,000. The whole twelve districts in existence at the end of 1910 will include some 37,000 acres of land rated for irrigation, with works estimated to cost about £165,000. Several other large schemes involving the

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formation of irrigation districts have been investigated, some at least of which will fructify.

Only those who know how mutually suspicious of one another the farmers have been in the past, particularly where questions of water-rights were concerned, can appreciate the great advance achieved by the formation of these irrigation districts, necessitating the placing of individual interests under the control of boards for mutual benefit. Again, those who know the farmer will recognise how much greater influence one successful example will have with them than much precept, and will understand the beneficial influence which a dozen such schemes carried out successfully in different parts of the country may have. They will understand also the necessity that such schemes should be successful.

In order to ensure success, so far as possible the Government provides, at nominal charge, the services of the professional staff of the Irrigation Department to make preliminary investigations, and, if the conditions are favourable, to design and advise as to construction of the necessary works, but does not undertake the construction of the works, which is done directly by the boards, who employ contractors or work administratively under the advice of the Department.

These schemes usually consist of a weir and furrow, with occasional siphon or aqueduct to carry the water across valleys or river courses, and the usual regulators, spillways and other incidental works. The largest of the irrigation board works yet carried out is the Breede River at Robertson, which includes an area of 5,576 acres of rated land. The smallest is Vekeerde Vlei, with only 500 acres. The amount per acre which may profitably be expended upon irrigation works will of course depend greatly on the quality of the land, the crops proposed to be grown, facilities for transport, and other conditions. Five to ten pounds per acre in capital expenditure are ordinary figures for South Africa. Few works have cost less than £5, and some have cost considerably more than £10. A higher expenditure would generally be justifiable where permanent water was available than where it was intermittent.

Under the fostering care of the Irrigation Department, the method of irrigation by pumping has been largely extended and generally with very encouraging results. As already remarked, many of the rivers of the country flow in very deep channels, and often with very slight fall, so that to lead the water out by gravitation may be impracticable in connection with schemes dealing with comparatively small areas of ground. For example, the Orange River, over 400 miles of its course, from Aliwal North to Prieska, has an average fall of only 3½ feet per mile, whilst for the lowest stretch of 70 to 80 miles it has less than 1½ feet per mile. The Vaal, from Vereeniging to its junction with the Orange, a distance of some 520 miles, has an average fall of only about 2½ feet per mile. These are probably examples of two of the flattest slopes. The Breede River, from Worcester to Swellendam, which length includes the best lands on the river, has a general slope of about 4½ feet per mile. The Great Fish River, for 100 miles below Fish River Station, falls about 11 feet per mile, and 5 to 10 feet per mile is probably a common slope for Karoo streams.

Irrigation by Pumping.

It is evident that with such slopes, coupled with very deep river channels, it would generally be necessary to carry a canal a good many miles in order to gain command of the land, and such canal would probably extend beyond the upper boundary of the property on which the land to be irrigated was situated.

It is much simpler, therefore, in many cases, if a pumping plant can be put down immediately adjoining the irrigable land, as by that means the capital outlay required may be much reduced and complications with adjoining proprietors avoided.

During the three years ending December, 1909, the Irrigation Department advised on sixty-three pumping schemes of this nature, which in the aggregate cost about £41,000, and irrigate some 6,000 acres. About £20,000 of the total cost was loaned by the Government. Of these sixty-three installations, fifty were suction gas-power plants, which have generally given much satisfaction and in many cases replaced oil or steam engines with advantage.

In addition to these works it is known that a good many others of a similiar nature have been carried out without Government aid. Of pumping plants driven by oil engines about 140 are known to the Department, and there are probably others, so that irrigation by pumping has now become a feature in the development of the country, and its adoption is likely to increase in the future.

It need hardly be said that the average pumping scheme, although it may cost less per acre in capital outlay, will, when working expenses are

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included, generally cost more per acre per annum than a favourable gravitation scheme. Hence a pumping plant would not be put down where a gravitation scheme could be readily carried out, but many cases occur where, irrigation by gravitation not being practicable, it will be well worth while to water a few hundred acres by pumping. In a pumping scheme there is the great advantage that, the water being generally delivered on the ground by a pipe, there is less loss than with a long furrow, so that a much higher duty is obtained for the water.

The cost of pumping water will obviously vary considerably with local conditions. Near the coast, where overland transport charges are not high, the cost per acre per annum of placing two feet of water on the land would probably vary from £1 to £2 for a 50-foot lift, to £1 10*s.* to £2 10*s.* for a 150-foot lift, including 10 per cent. depreciation on capital. Up country these figures might be increased to £2 10*s.* and £3 respectively.

Financial Results.

Whatever arguments may be advanced in support of irrigation, it must finally be submitted to the financial test—Will it pay? We shall therefore just glance rapidly at this aspect of the question, and see what returns are to be looked for on capital laid out.

Since lucerne is the crop which has for some years past claimed the most attention from irrigators, we may start off by looking at the results to be obtained from that crop.

The most profitable method of working is, speaking generally, by grazing it. It may be fed to dairy cattle or ostriches, or to sheep or cattle for slaughter. In this way returns of 22 to 40 per cent. per annum on the capital invested may be obtained. The favour with which this crop has come to be looked upon is no doubt due, in great measure, to the high net value of produce which is obtained per acre. Reliable figures place its value as pasturage at from £25 to £45 per acre per annum, whilst if made into hay, £15 to £20 per acre may be cleared. Nothing like such returns can be expected from any cereal crops, though they may be equalled, or even exceeded, by fruits or vegetables, but these, particularly the latter, require more labour to produce, are more dependent upon the proximity of a local market, and generally more easy of over production.

It is not right, however, to allow oneself to be carried away by the high values per acre obtained. The real test is the percentage returned on capital invested, and, when looked at from this point of view, the lucerne will not be found to give greatly better results than some other crops. Lucerne requires the best land for growing to perfection. Particularly, the soil must be deep, for the plant sends its roots to a great depth, and it must contain a fair amount of lime. Where soil of suitable quality can be had—and the quantity yet appropriated is a mere fraction of that available—there can be little doubt that lucerne is in many respects a very satisfactory and profitable crop. It has the immense advantage of being a permanent crop which, once established, will, with proper care, continue to yield good returns for many years. It is a very hardy plant, and in case of shortage of water will not suffer permanent damage. Sending its roots deep down in the soil, it will stand a severe drought, and though, of course, it will not yield a crop whilst deprived of water, it will remain healthy, and be ready to respond when water is again available.

All land, however, is not suited for lucerne, and much which is not may yield excellent returns with cereals or other crops. The best return in weight of grain from wheat is probably obtained in the Transvaal, where it is grown under permanent irrigation. The yield averages from eight to ten bags (of 200 lbs.) per acre, the net profit on which may be taken at about £2 to £3. On the Zak River, already referred to, three and a half bags per acre may be taken as an average yield from Zaai dam cultivation, and here again a net profit may be put at about £2 per acre per annum. These yields are averages taking one year with another, and whilst the irrigation in the Transvaal is with perennial water, that on the Zak is with intermittent and uncertain, which in some years fails to come down at all, or in so small quantity that no seed is sown; the district, however, has the benefit of a cheaper if more primitive system of irrigation, which places a lesser burden of cost per acre on the area watered.

The table following shows the value per acre per annum of several crops named, and the percentage returns on capital outlay, giving in each case a fair market value to the land according to the use to which it is put.

For some of the information on which the figures given are based, the author is indebted to Mr. Oscar Evans and other experienced ostrich breeders, and lucerne growers, whose experience is given in a pamphlet, "Money in Lucerne," to the publishers of the same, the Midland Printing and Publishing Company, and also to Mr. Burtt-Davy, Government Botanist.

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Crop.	Net Value of Crop per Acre.	Capital Invested per Acre.	Return on Capital per cent.	Acres required to Produce Profit of £1,000 per Annum.
Lucerne grazed	£20 to £45	£120	20 to 40	22 to 40
,, hay	£18	£60	30	55
Wheat, Transvaal	£2 to £3	£8 to £10	20 to 35	330 to 500
,, Zak River . . .	£2	£5 to £7	30 to 40	500
It may be of interest to compare with these some figures for dry farming.				
Wheat, Malmesbury . . .	18s.	£3	30	1111
Mealies, Transvaal . . .	£2 to £3	£4 to £5 10s.	40 to 50	330 to 500

The obvious lesson of this table is that although irrigation may not yield a much higher percentage return on capital than other methods of farming, it does enormously increase the productiveness of the land—*i.e.*, whilst it does not increase appreciably the return per £1 invested, it vastly increases the return per acre of land worked. The last column in the table has been added to bring out this feature, and it shows that whereas with dry farming, in order to obtain an income of £1,000 per annum, it would be necessary to work from 300 to 1,100 acres, the same result might be achieved with from 22 to 55 acres of land under irrigation.

This fact is of interest to the individual farmer as indicating a saving on personal wear and tear, and in the amount of labour to be provided, but is even more so to the state as showing how irrigation may serve to render the land capable of more intense cultivation, and so of supporting a greater population.

It seems probable that for some time to come the efforts of the Government must be directed rather to assisting in the development of smaller works, such as those of irrigation boards and farmers, than to initiating extensive schemes.

Several large schemes have been investigated in the past. One to irrigate 40,000 acres was worked up in the Breede River a few years ago, but was not taken very kindly to by the farmers, and there is little doubt that before long quite as large an area will in the same district be put under irrigation by means of several smaller projects.

To the writer it appears that, apart from general guidance and advice, the work which the Government should make its speciality is the storage of surplus waters. That is a matter generally too comprehensive to be tackled by the riparian owners. Even in the hands of Government the distribution of the water will be a matter far from simple, but the longer it is delayed the more vested interests there will be to propitiate.

DISCUSSION.

The Chairman (the Hon. Sir Richard Solomon), in opening the discussion, said he did not intend to criticise the paper, because he did not feel competent to do so, but there were two inferences from facts to which attention had been called in the paper on which he desired to make a few observations. He inferred from certain facts that had been placed before the audience, that, first of all, South Africa needed a much larger white population, and secondly, that the land of South Africa under proper conditions was capable of sustaining a larger white population and able to produce sufficient food-stuffs for the consumption of its own population. He desired in the remarks he wished to make to indicate the steps the Government of the Union were taking in relation to that question. The author had pointed out that within the Union of South Africa, the European population numbered only about a quarter of the aboriginal native population; but a more serious fact was that, judging from the census taken in 1911, the native population since 1904, when the last census was taken, had increased proportionately more than the European population had done, the increase in the former being about 16 per cent. and in the latter about 14 per cent. He had seen it stated, and he believed it to be true, that that was the first time in the history of South Africa when, between the taking of two censuses, the European population had increased less rapidly than the native population had done. He had no hesitation in saying that as far as he could see the native population would go on rapidly increasing. The causes which at one time operated to reduce the native population were happily no longer in existence. Tribal fights could not be tolerated in a

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country where civilised law prevailed, and it was no longer possible for powerful native chiefs, like Chaka, Dingaan and Lobenguela, to slaughter at their sweet will hundreds and thousands of their subjects. Famine, which at one time frequently reduced the native population, had been entirely eliminated by the constant and increasing demand for native labourers and by the comparatively high wages paid them, especially at the mines at Johannesburg; while intoxicating liquor, so destructive to primitive races, was forbidden to be sold almost everywhere within the Union to the native population. It appeared to him perfectly clear that if the European population in South Africa was to hold its own, and to maintain its supremacy and superiority, there must be accessions to its numbers from outside. In respect of immigration, South Africa was in a different position from Canada and Australia. Many Europeans went to Canada and Australia as farm labourers and ordinary unskilled workers, but in South Africa all the unskilled work on the farms, in the mines, and in the different industrial undertakings was performed by natives. There was a rooted conviction amongst the European population, not only amongst those born on the soil, but those who went to South Africa from this country, that it was degrading to do unskilled work because it was looked upon as black man's work. Personally, he believed that time, and the acute demand for labour, would kill that prejudice, but as long as it continued, there was little or no demand in South Africa for unskilled European labour. But, as the author had stated, there was plenty of land in South Africa of rich soil, and there was a most perfect climate, great assets to a young country which wished to increase its European population. The Government desired to place more land under cultivation in South Africa, and to obtain more European producers. The author had stated that there were imported every year into the Union of South Africa, millions of pounds' worth of food-stuffs, which ought to be grown in the country. During the first ten months of 1911, he found that about one million pounds' worth of wheat and flour had been imported into the Union, and about a million pounds' worth of meat, butter and milk. All those articles could and ought to be produced in South Africa. He had often spoken to farmers in South Africa who had farmed in Australia and New Zealand, and had been told by them that South Africa was a better colony to farm in than either of the other two, and yet Australia and New Zealand exported thousands of pounds' worth of food-stuffs to Europe, while South Africa imported thousands of pounds of food-stuff into the Union. Why was that the case? They had the land, the climate, and the soil, but it was necessary to consider the difficulties that existed in the past to which the author had referred, namely, the difficulties in connection with irrigation and land settlement. He trusted that those difficulties were now of the past. Great struggles had taken place in South Africa, which he hoped were now over. They had to look into the future, and the policy of the future was to prepare the land for settlement by judicious schemes of irrigation, and by extension of railways. A large European population would thus be obtained upon the land, which would successfully cultivate it and produce sufficient food-stuffs, not only for the consumption of the people of South Africa, but for export to the Mother Country. It was natural the question should be asked: What was the policy of the Government going to be in connection with those matters? There was no doubt whatever that they were receiving the serious attention of the Government of South Africa. Railways were being extended throughout the length and breadth of the Union. Fifty years ago he did not suppose there were fifty miles of railway in the whole of the country which now comprised the Union; at the present day there were 9,000 miles in actual use and many hundreds more being constructed; and the demand for railway construction was constant and persistent. Telephones were being constructed to different farms in the country, by means of which it was possible to communicate with the nearest markets; and during the present session of Parliament the Government intended to introduce a Land Settlement Bill, under which power was given to them to appropriate unoccupied Crown lands, of which there were about five million acres within the Union, and also to purchase private land for the purpose of settling people upon it. The Bill also provided for settling the right people on the land, and for giving them easy terms of hiring and of purchase. It was intended to introduce an Irrigation Bill during the present session which modified some of those principles of the common law which the author had stated were so strictly interpreted by courts of law, and which raised very great difficulties in the way of irrigation schemes in a country where severe droughts occasionally occurred; where in many parts the rainfall was insignificant, where the rivers ran in deep channels, and for a considerable portion of the year some of them were absolutely dry, and then after a thunderstorm became raging torrents. The Irrigation Bill also provided for the establishment of water boards and irrigation boards, and, perhaps what was more important than all, authorisation was given to the Government to make loans at low rates of interest to private individuals and to irrigation boards for the purpose of constructing the irrigation works. Perhaps the most important practical step which the Government intended to take, which it had already announced, was to raise a loan of five million pounds for the purpose of land settlement and irrigation works, and for the general development of the agricultural industry. Acts of Parliament looked exceedingly well upon paper, but unless money was available to carry out the objects of the Acts they became dead letters. It was very difficult indeed for a private farmer to make irrigation works of his own; he had to be assisted by the Government, and with the pecuniary assistance which the Government proposed to give to private

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individuals and irrigation boards he had no doubt that the irrigation which was so essential to the cultivation of the soil in South Africa would progress by leaps and bounds. He therefore thought they might confidently look forward to a great future for the agricultural industry of South Africa, and to the time when the Union would not only produce all the food-stuffs necessary for its own population, but would become one of the principal exporters of those articles to the European markets.

Sir Hanbury Brown, K.C.M.G., said that in these days of powerful navies and world-wide naval strategy, it was a sound principle for every country to grow as much of its own food as it could on its own soil, and not to depend upon possible enemies for any of its food-supply. It seemed from the paper that South Africa had violated that principle. Its mineral wealth had been exploited; its agricultural development had been neglected; but it appeared from what the Chairman had said, that South Africa had repented and was going to mend its ways. It was a country of cultivable soil and of deficient rainfall, and therefore irrigation was the thing needful. The practical question seemed to be where and to what extent the Government should step in and take control of the irrigation. It was a very rash thing for anybody who had not been in South Africa to make suggestions, but, nevertheless, he would mention a few ideas that had struck him on reading the paper, with nothing but the *Times* atlas before him. To one whose experience was of irrigation in Egypt, there were two passages in the paper which contained rather striking statements, one being the statement that almost all the cultivated land lay between 2,000 feet and 6,500 feet above the sea; and the other that the rivers running in deep channels had *very flat slopes* of from 1½ to 3½ feet per mile. When he read the paper he thought that feet was a misprint for inches, the slope of the Nile being only 5 inches to a mile. What the author evidently meant was that the *surface slope of the country* was not steep enough to allow of the water being led out from the deep river channels and brought to the country surface without digging canals of such length as would be inadmissible in the case of small areas on account of the relatively excessive cost, even if the lie of the land would allow of canals of such a length being dug. The fact that the cultivated land in South Africa lay at such a high altitude formed a very strange contrast to the land of Egypt. All the cultivated land in the Delta of Egypt lay between fifty feet and nothing above the sea; and on the west of the Delta near Alexandria there were cultivated lands which were even below the level of the sea. In the Delta of Egypt great difficulty was therefore experienced with regard to the drainage of the country, and much of the drainage water had to be lifted by powerful machinery. In South Africa, with a fall to the sea of 2,000 to 6,500 feet, the irrigation officers would not be met with that drainage difficulty; and for this they might be thankful. With regard to the question of irrigation in South Africa, he proceeded to consider whether there was any field for a big single irrigation project of wide extent, as Indian and Egyptian officers would understand the words "wide extent." He was inclined to think there was one. The Orange River had its source in the Drakensburg Mountains, which were on the east side of the Continent not far from the coast where the rainfall was copious, and the river ran from east to west through lands where the rainfall was deficient. Below the junction of the Vaal with the Orange River there was no important tributary carrying perennial water which came into the parent stream. So that it seemed to him, after studying a small scale-map, that Prieska was not unlikely a favourable place for the head-works of a canal project for the irrigation of the land to the west of it, such as the Government might draw up, execute, and control. With regard to other smaller river systems, excepting perhaps the Limpopo, the best arrangement, it seemed to him, was one that was adopted in France, namely, that the interested parties should form themselves into syndicates, or associations, with power to carry out and work canal systems, with perhaps a grant from the Government and the expert advice of the Government's irrigation engineers. That, he gathered from the paper, was practically the method adopted in South Africa. The associations, he supposed, would be assisted by the irrigation boards, and over them would be the river boards, which he presumed were district irrigation departments with some of the powers of a Government department. That, it seemed to him, was a system which was suitable to the conditions of the smaller river schemes. The concluding sentence of the paper repeated the warning made by Sir William Willcocks in 1901, that the Government should declare all the rivers and natural watercourses to be part of the public domain. It was easy to understand the necessity for that. It was only necessary to imagine two associations, one high up the river and the other lower down, each intent on developing land by irrigation from the river. As soon as the development had reached that stage at which all the available water-supply in the river was utilised for irrigation, then any further development by the upper association must be followed by a decrease in the cultivation of the lower one, and there would be no net gain. The Nile furnished a good illustration of such a situation. During the nineteenth century the summer cultivation of Egypt was developed to such an extent that eventually every drop of the natural flow of the river in summer was utilised in irrigation. There was now a paternal Government in charge of the Sudan anxious to develop the resources of the country. Among the things it wished to develop was the summer irrigation of cotton cultivation. But it was not able to do that without taking water out of the river in summer, and that the Sudan could not be allowed to do without restriction, except at the

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expense of Lower Egypt. So that the Government kept a tight hand on the River Nile, and the Sudan was only allowed to take out water in the summer to a very limited extent. So, before all else, as a preliminary to any scheme of canal administration, the right of the public to its own natural water-supply must be safeguarded against any exclusive appropriation of it by individuals, and the author had done well to conclude his paper by a reference to that necessity.

MR. R. B. BUCKLEY, C.S.I., said there were two points in the report written by Sir William Willcocks, to which both the author and Sir Hanbury Brown had referred, which seemed to him to bear out a good deal of what had been heard in the author's interesting paper. In one part Sir William Willcocks said: "It is quite obvious that the future development of the agricultural industry in South Africa depends almost entirely upon irrigation." And in another part he said: "When rain is wanted it is generally not there, and when it is not wanted it is invariably present. In a country so situated, the only possible means of development lie in the storage of water when it is present and not needed, and its utilisation by irrigation when it is needed." The two main facts which struck him as having been brought out by the paper agreed with those statements. The author had referred to the extremely variable nature of the rainfall in South Africa, and the condition of some of the rivers which had been cut away by the heavy scour of the floods which occasionally occurred. Most people would admit that two things were absolutely necessary for any irrigation scheme, although, curiously enough, some people who were not acquainted with the details of irrigation would admit the necessity of one, but rarely admit the necessity of the other. It was necessary, in the first place, to have land to irrigate, and, in the second place, water to irrigate with. The audience might think it very absurd of him to say such a thing, but it really was the fact that some people who were not acquainted with irrigation did not seem to think it was necessary to have the water. They thought it was only necessary to have an irrigation officer, and if such a gentleman was obtained it necessarily followed that the water would also be obtained. That was not true. South Africa was a country which eminently desired irrigation, but it was a country which did not lend itself generally to successful schemes of large irrigation; it lent itself in many ways to small and comparatively restricted projects. Sir Hanbury Brown had referred to the possibility of irrigation from the Orange River. Personally, he believed that was the only large river from which any extensive irrigation was possible. Sir William Willcocks in the extract he had read referred to the fact that if the resources of South Africa were to be developed by means of irrigation it was necessary to store the water. It was very difficult indeed to get people to believe that it was impossible to store all the water that came down from the sky. To illustrate the point of the very varying amounts of water which could be obtained from the same volume of rainfall, the following particulars with regard to a reservoir at Nagpur would be of interest. On one occasion a rainfall of 2·20 inches fell on the catchment area of the reservoir in eighty minutes; on another occasion in the same year a rainfall of 2·24 inches fell in precisely the same time. One rainfall put into the reservoir not a single drop of water independently of that which actually fell into the reservoir itself; the second rainfall poured in 98 per cent. of the water which fell on the catchment. The explanation of that apparently astonishing fact was extremely simple. The first fall occurred when the catchment, which was a rocky one, was very dry, and was to a large extent at once dissipated in vapour from the soil or absorbed by the crevices in the land. On the second occasion the land had been wetted for some time before the rainfall, and the whole of it flowed off. Somewhat similar experiences had occurred in Cape Colony. He recently came across a case mentioned by Mr. Newry, in which a certain catchment of thirty-six square miles had a rainfall of 19 inches in the year, and about 20 per cent. of the water was obtained off it; while in another year there were 33 inches of rainfall and only 9 per cent. of it came off. It was a fact that a dry year, when water was most required for irrigation, was the very time when it was most difficult to get it into the reservoir. In a year when the rainfall was heaviest, which was the time when water was least wanted for irrigation, it was comparatively easy to get the water into the reservoir. So that a reservoir was not always a complete remedy for irrigation troubles, and he therefore desired to utter a word of warning with reference to the construction of reservoirs in South Africa. The rainfall in South Africa was generally much dispersed. With a light rainfall a very small amount of the water came off into the reservoir. Now and again very heavy showers occurred which produced heavy floods, but he was told they were rare in South Africa. In any project for the construction of a reservoir in South Africa it must be borne in mind that it was extremely doubtful whether the amount of water would be got into it which had been calculated in the paper. It was stated that 5 per cent. of the rainfall was likely to be conserved. Personally, he confessed he was very doubtful on that point. There were a great many reservoirs in India, mainly in the Province of Bombay. In that Province the rain did not fall, as it fell in South Africa, widely dispersed over the year; it all fell practically in four or five months, which proved that it was much easier to collect the water in that time than when it fell in twelve months. But the experience of 175 observations, extending over twelve or eighteen years, of various reservoirs in India, showed that even in those four or five months not more than 10 per cent. of the rainfall, which during those months

was about as great as was obtained in South Africa during the whole year, went into the reservoir. There were cases in which 20 per cent. of the water was obtained, and others in which 40 per cent. was obtained, but in many cases only 9 per cent. was obtained. That was borne out by some observations made in the Transvaal by Mr. Strange, who, in writing with regard to observations that had been going on for some time, said:—"The returns are very disappointing, as they show that but an insignificant percentage of the rainfall found its way into the rivers." He therefore thought that if reservoirs were constructed in South Africa disappointing results would follow in many cases. He noticed the author had stated that in Cape Colony the water-supply would probably be sufficient to irrigate 2,700,000 acres. Experience in Egypt and India had shown that in the irrigated tracts a population of something like one person to an acre was required to do it efficiently. In Egypt there were something like 600 people to the square mile, and in the parts of India which were largely irrigated there were about 400 to 500 to the square mile. To deal with 2,700,000 acres of irrigation in Cape Colony would require more than the entire present white and black population of the whole Colony to be turned on to the land, so that if that forecast of 2,700,000 acres was to be realised it meant that a large increase in the population must be obtained.

Mr. R. E. Brounger said that, as a railway engineer, he had been connected with the construction of railways in South Africa, and in that capacity had experienced the difficulties and privations which lack of water involved. When the railway was being built from Cape Town to Kimberley, across the Karoo, many an instance occurred in which water had to be carted forty miles for the making of the mortar for the construction of bridges and culverts, and for the workmen to drink. An amusing story was told of the difficulties connected with the absence of water in Kimberley in the early days, it being said that some of the wealthy people who were able to afford baths used to buy two or three dozen bottles of soda water and have a bath once a month.

Sir Clement Hill, K.C.B., K.C.M.G., M.P., proposed a hearty vote of thanks to the author for his most interesting and instructive paper.

Sir Colin Scott Moncrieff, K.C.S.I., K.C.M.G., in seconding the resolution, at the same time expressed the thanks of the audience to the High Commissioner for his kindness in occupying the chair.

The resolution of thanks having been carried with acclamation,

Mr. W. A. Legg, in reply, thanked those present for their kind vote of thanks and the cordial reception they had given the paper. In reply to Sir Hanbury Brown's remarks with regard to the slope of the rivers, when he (the author) said it was a small slope, that must be taken in conjunction with the fact of the channels being very deep, and also that the water, when it did run in those channels, did not run to a very great depth as a rule, and was perhaps from 20 to 30 feet below the surface of the adjoining ground which it was proposed to irrigate. That made a slope of even 2 or 3 feet per mile rather a small one when it was necessary to lift the water from such a great depth below the surface of the ground to get it on to the land. In dealing with the question of storage, Sir Hanbury Brown suggested that the Government should take control of the surplus water. That would be the ideal thing to do, but it might not prove to be quite such an easy thing to carry out in South Africa as it was in Egypt, because there were so many vested interests in South Africa which would have to be dealt with before that could be done on a large scale. He desired to say to Mr. Buckley that the rainfalls which were shown in the table were typical of the Karoo country, and not of the whole of South Africa. In many parts of the country a rainfall of two inches in a day very often occurred, although it was not at all common on the Karoo.

NINTH ORDINARY MEETING.

Wednesday, February 7th, 1912; Lord Sanderson, G.C.B., K.C.M.G., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bieber, Miss Caroline Frances, F.Z.S., 25, Wetherby-gardens, South Kensington, S.W.

Heaven, Frances Gyde, 132, Gresham House, Old Broad-street, E.C.

Lee, Ivy L., 24, Throgmorton-street, E.C.

Randall, Wilfrid Levison, F.S.A.M., Port House, Brimscombe, Gloucestershire.

Wallis-Tayler, Alexander James, Assoc.M.Inst.C.E., "Esquimalt," Robin Hood-lane, Sutton, Surrey.

The following candidates were balloted for and duly elected members of the Society:—

Buchanan, James, J.P., Lavington Park, Petworth, Sussex.

Jones, Harry, 32, Acfold-road, Fulham, S.W.

The paper read was—

THE INFLUENCE OF OZONE IN VENTILATION.

By Leonard Hill, M.B., F.R.S.,
and
Martin Flack, M.A., M.B., B.Ch.

The good effects which result from efficient ventilation and open-air treatment are generally supposed to be due to the chemical purity of the air. They are due really to the movement,

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coolness, relative humidity of the air, and to the ceaseless variation of these qualities. The ventilating engineer has hitherto followed a great illusion in thinking that the main object to be attained is chemical purity of the air. The heating engineer has sought after an equally great illusion in striving to give us a uniform summer temperature (Pembrey). The ventilating and heating engineers primarily should aim at giving us air which is cool, of proper relative humidity, and which moves so as to vary the cutaneous state of the body. Our comfort and discomfort in crowded rooms and shut-up places depends, not on the chemical purity of the air, but, to a minor degree, on the influence of the smell of the air on the olfactory sense, and, to a vast degree, on the influence of the temperature, relative humidity, and the variations of these qualities of the air, which act on the great field of cutaneous sensibility.

It is needless to point out that our sense of well-being depends to a very great degree on the comfortable condition of our skin, and yet the ventilating and heating engineers have paid little attention to this. While asserting that the chemical purity is of no account, we make the proviso that the air is only altered by the presence of human beings, and is neither rendered poisonous by the escape of coal gas, or other noxious trade product, nor deoxygenated by the oxidative processes of the soil, as it is in mines. We are speaking of the discomfort and ill-health caused by the deficient ventilation of, or bad methods of heating, dwelling-houses, schools, factories, theatres, chapels, etc.

The chemical purity of the air can be considered from three points of view, the concentration of CO_2, the concentration of O_2, the supposed presence of organic poison exhaled in the breath.

Owing to the fact that a percentage of CO_2 is not legally permissible in factories which exceeds a very few parts per thousand, it is commonly supposed that any greater excess of CO_2 acts as a poison.

The truth of the matter is quite otherwise; for, whatever the percentage of CO_2 in the atmosphere may be, that in the pulmonary air is kept constant at about 5 per cent. of an atmosphere by the action of the respiratory centre. It is the concentration of CO_2 which rules the respiratory centre, and to such purpose as to keep the concentration both in the lungs and in the blood uniformly about the same. This fact, which was first firmly established by Dr. John Haldane, is of fundamental importance.

It is impossible that any excess of CO_2 should enter into our bodies when we breathe the air of the worst-ventilated room in which the percentage of CO_2 assuredly does not rise above 0·5 per cent., or at the outside 1 per cent. The only result from breathing such an excess of CO_2 is a slight and unnoticeable increase in the ventilation of the lungs. The increased ventilation is exactly adjusted so as to keep the concentration of CO_2 in the lungs at the normal 5 per cent. of an atmosphere. The very same thing happens when we take gentle exercise, and produce more CO_2 in our bodies; the pulmonary ventilation is then slightly increased, and thus the CO_2 concentration in the blood and lungs is kept at the same uniform level. At each breath we rebreathe into our lungs the air in the nose and large air-tubes (the dead space air), and about one-third of the air which is inhaled into the lungs is "dead space" air. Thus, no man breathes in pure outside air into his lungs, but air contaminated perhaps by one-third, or (on deep breathing) by one-tenth with expired air. When a child goes to sleep with its head partly buried under the bed-clothes, and in a cradle with the air confined by curtains, he rebreathes the expired air to a still greater extent, and so with all animals that snuggle together for warmth's sake. Not only the new-born babe sleeping against its mother's breast, but pigs in a stye, young rabbits, rats and mice clustered together in their nests, young chicks under the brooding hen, all alike breathe a far higher percentage than that allowed in our factories by the officials of the Home Office. To rebreathe one's own breath is a natural and inevitable performance, and to breathe some of the air exhaled by another is the common lot of men who, like animals, have to crowd together and husband their heat in fighting the inclemency of the temperate and Arctic zones. By a series of observations made on rats confined in cages with small ill-ventilated sleeping chambers, we have found that the temperature and humidity of the air—not the carbonic acid and oxygen concentration of the air—determines whether the animals stay inside the sleeping-room or come outside. When the air is cold, they like to stay inside, even when the carbonic acid rises to 4 per cent. or 5 per cent. of an atmosphere. When the sleeping chamber is made too hot and moist they come outside.

In breweries the men who tend the fermentation vats work for long hours in concentrations of CO_2 of 0·5 to 1·5 per cent. (Lehmann). Such men are no less healthy and long-lived

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than those engaged in other processes of the brewing trade. In the Albion Brewery we analysed on three different days the air of the room where the carbonic acid gas, generated in the vats, is compressed and bottled as liquid carbonic acid. We found 0·4 per cent. to over 1 per cent. of carbonic acid in the atmosphere of that room. The men engaged therein worked twelve-hour shifts, having their meals in the room. They had followed this employment for eighteen years, and without detriment to their health. It is only when we come to the higher concentrations of CO_2, such as 3 per cent. to 4 per cent. of an atmosphere, that the respiration is increased so that it is noticeable to the individual himself, and such percentages, of course, diminish the power to do work; for the excess of CO_2 produced by the work adds its effect to the excess in the air, and the limit of panting is soon reached. Thus the power to work is checked. Divers who work in diving dresses, and men who work in compressed-air caissons, constantly work in concentrations of CO_2 higher than 1 per cent. of an atmosphere, and so long as the CO_2 is kept below 2 per cent. to 3 per cent. of an atmosphere, they are capable of carrying out efficient work.

It results, then, from what we have said, that concentrations of CO_2, such as occur in the most crowded and worst-ventilated rooms, are of no account. Forced to admit this fact, the hygienist has fallen back on the hypothesis that organic chemical poisons are exhaled in the breath, and that the percentage of CO_2 is a valuable guide as to the concentration of these. It is necessary, he says, to keep the CO_2 below 0·1 per thousand, so that the organic poisons may not collect to a harmful extent.

Before we turn to the discussion concerning the supposed existence of these organic chemical poisons, we will deal with the question of oxygen. The oxygen in the worst-ventilated schoolroom, chapel, or theatre, is never lessened by more than 1 per cent. of an atmosphere. The ventilation through chink and cranny, chimney, door and window, and the porous brick wall, suffices to prevent a greater diminution of the oxygen concentration. Now, in all the noted health resorts of the Swiss mountains, such as St. Moritz, the concentration of oxygen is lessened considerably more than this. On the high plateaux of the Andes there are great cities: Potosi, with 100,000 inhabitants, is at 4,165 metres (barometric pressure about 450 mm. Hg.); railways and mines have been built even at altitudes of 14,000 to 15,000 ft. Owing to the nature of the chemical combination of oxygen with hæmoglobin, man can adjust himself to very great variations in oxygen concentration. At Potosi girls dance half the night, and toreadors display their skill in the bull-ring. We have watched our students, shut in an air-tight chamber, until they came to breathe air containing only about 16 per cent. of oxygen and 3½ per cent. of carbonic acid, and seen their puzzled look when they found they were unable to light a match and smoke a cigarette. There was then too low a percentage of oxygen to support combustion, but of this they were quite unaware. All the evidence goes to show that it is only when oxygen is lowered below a pressure of 14 per cent. to 15 per cent. of an atmosphere, that signs of oxygen want arise. A diminution of 1 per cent. of an atmosphere has not the slightest effect on our health or comfort.

We must now discuss the evidence for the existence of organic chemical poison in the exhaled breath. The evil smell of crowded rooms is accepted by most as unequivocal evidence of the existence of such. This smell, however, is only sensed by, and excites disgust in, one who comes to it from the outside air. He who is inside and helps to make the "fugg" is both wholly unaware of, and unaffected by, it. Fluegge points out, with justice, that while we naturally avoid any smell that excites disgust and puts us off our appetite, yet the offensive quality of the smell does not prove its poisonous nature. For the smell of the trade or food of one man may be horrible and loathsome to another not used to such. The sight of a slaughterer and the smell of dead meat may be loathly to the sensitive poet, but the slaughterer is none the less healthy. The clang and jar of an engineer's workshop may be unendurable to a highly-strung artist or author, but the artificers miss the stoppage of the noisy clatter. The stench of glue-works, fried-fish shops, soap and bone manure works, middens, sewers, become as nothing to those engaged in such, and the lives of the workers are in no wise shortened by the stench they endure. The nose ceases to respond to the uniformity of the impulse, and the stench clearly does not betoken in any of these cases the existence of a chemical organic poison. On descending into a sewer, after the first ten minutes, the nose ceases to smell the stench; the air therein is usually found to be far freer from bacteria than the air in a schoolroom or tenement (Haldane).

If we turn to foodstuffs, we recognise that

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the smell of alcohol and of Stilton or Camembert cheese is horrible to a child or dog, while the smell of putrid fish—the meal of the Siberian native—excites no less disgust in an epicure, who welcomes the cheese. Among the hardiest and healthiest of men are the North Sea fishermen, who sleep in the cabins of trawlers reeking with fish and oil, and for the sake of warmth shut themselves up until the lamp may go out from want of oxygen. The stench of such surroundings may effectually put the sensitive, untrained brain-worker off his appetite, but the robust health of the fisherman proves that this effect is nervous in origin, and not due to a chemical organic poison in the air. The supposed existence of organic chemical poison in the expired air is based upon experiments of Brown-Sequard and d'Arsonval. They injected into guinea-pigs and rabbits either the condensation water obtained from the breath, or water which they used several times over to wash out the trachea of dogs. The water was injected subcutaneously and in large amounts, and produced in their hands signs of illness, collapse and death.

These experiments have been repeated by many others, and with negative results by those whose methods of work demand most respect—Dastre and Loye, Van Hofmann Wellenhof, Lehmann and Jessen, Haldane and Smith, Weir Mitchell and Borgey, etc. A few confirmatory results have been obtained by methods of experiment which are truly absurd in their conception. One to two cubic centimetres of condensation water (obtained by breathing through a cooled flask) have been injected into a mouse weighing 13 grams or so. This is equivalent to injecting five litres of water into a man weighing 65 kilos. Who would not be made ill by the injection of about nine pints of cold water beneath his skin? It has been shown that injections of pure water alone in doses of over one cubic centimetre may make a mouse ill (Inaha). Such experiments are ridiculous, and deserve not a moment's attention.

In the case of Brown-Sequard and d'Arsonval's experiments they injected from 4 to 44 cubic centimetres into guinea-pigs and rabbits, either directly into the circulation or subcutaneously. Using the washings of a dog's trachea, or the condensation fluid obtained from the breath, they could not fail to inject traces of the proteins of the saliva. A second injection of such into the same animal might produce the well-known anaphylactic shock. By subcutaneous injection of a foreign protein an animal becomes sensitised, and may be poisoned by a subsequent injection of the same. The sensitivity may be produced by extraordinary small doses—*e.g.*, one millionth of a 1 c.c. of serum. Anaphylaxis is never produced by the injection of protein taken from the same species of animal, nor can it be produced by eating foreign protein. There is no reason to suppose that it can be produced by breathing into the lungs traces of a foreign protein. Quite recently Rosenau and Amos have published experiments which seem to show that guinea-pigs can be sensitised by the injection of the condensation water of human breath, so that anaphylaxis is produced in these pigs by a subsequent injection of a trace of human serum. These observers breathed for six to ten hours through a glass tube fitted with a plug of glass wool. Owing to the method employed it seems certain that saliva must have wetted the glass wool, and, carried on in "droplet" form, contaminated the condensation water. Breathing through a tube leads to an expulsion of saliva which does not occur in natural breathing. The guinea-pigs, as we might expect, therefore became sensitised to human protein by the injection of the condensation water containing traces of salivary protein. The authors, however, do not take this view, and think that their results afford evidence in favour of the exhalation of a volatile protein—an organic chemical poison. We cannot admit this view. The question before us is—Do men breathe out a substance poisonous to man? If there were anything in the claims of the American authors, we should expect to find rats, which dwell in the same confined cage and breathe each other's breath, sensitive to the injection of a trace of each other's protein. We are informed, by those who study the phenomena of anaphylaxis, that no such sensitivity can be shown.

After studying the literature on this subject we are convinced that there is no positive evidence which demonstrates the poisonous nature of the condensation water obtained from the breath. We go further and say there is at present no trustworthy evidence of the existence of any such poison in the exhaled air. Brown-Sequard sought to substantiate his views by carrying out a different series of experiments. He arranged rabbits in a series of chambers, and led the air from one chamber to another, so that each succeeding chamber received the vitiated air from the one before it. In the end cage rabbits died, but if the air received into this cage were passed through sulphuric acid the rabbits remained alive.

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These experiments have been repeated with the greatest care by Haldane and Lorrain Smith; also by Beu, Rauer, Lübbert and Peters, Billings, Weir Mitchell and Borgey, Formanek, etc. It has been proved conclusively that no harm results so long as a sufficient air current is maintained to keep the carbonic acid below a poisonous amount. The animal in the last cage dies when the CO_2 reaches 10 to 12 per cent. If the CO_2 is kept down the animal in the last cage puts on weight and thrives as well as the animal in the first cage. Of course, it is necessary in such experiments to clean the chambers daily, and supply the animals with suitable food and bedding. We have repeated the experiments, in one case leading the air from a chamber containing three rats through a chamber containing a guinea-pig, and in another case leading the air from a chamber holding three rats through another chamber also holding three rats. The chambers were daily cleaned and fresh dry hay and food were put within. The guinea-pig lived in an atmosphere containing about $3\frac{1}{2}$ per cent. of carbonic acid, and put on nearly 100 grams in weight in three weeks, in this respect doing quite as well as another half-grown guinea-pig kept under normal conditions. The rats in the other second chamber did no less well. Thus the evidence obtained from this kind of experiment as to the existence of a poison in expired air is wholly negative. Brown-Sequard's result must be ascribed to suffocation arising from failure in experimental method. We accidentally lost four of our animals from suffocation after the experiment had continued for a month, owing to the chinking of a tube and consequent interruption of the air current. Benedict has shown that a man can live many days in a closed chamber in comfort without damage to his health, having not the slightest cognizance of any defect in ventilation, when the ventilation is so reduced that the carbonic acid accumulates in the chamber up to 1 per cent.—that is to say, so long as the air in the chamber is kept cool and dry. We have enclosed eight students in a small chamber holding about three cubic metres of air and kept them therein until the CO_2 reached 3 per cent. to 4 per cent., and the oxygen had fallen to 17 or 16 per cent. The wet-bulb temperature rose meanwhile to about 85° F., the dry-bulb a degree or two higher. The discomfort was very great, but this was relieved to an astonishing extent by putting on electric fans placed in the roof, whirling the air in the chamber, and so cooling the bodies of the students.

In a crowded room the air confined between the bodies and clothes of the people is almost warmed up to body temperature and saturated with moisture, so that cooling of the body by radiation, convection by evaporation, becomes almost impossible. This leads to sweating, wetness and flushing of the skin, and a rise of skin temperature. The blood is sent to the skin and stagnates there instead of passing in ample volume through the brain and viscera. Hence arise the feelings of discomfort and fatigue. The fans in our chamber whirled away the blanket of stationary wet air round their bodies, and brought to the students the somewhat cooler and drier air in the rest of the chamber, and so relieved the heat stagnation from which they suffered. The relief became far greater when we allowed cold water to circulate through a radiator placed in the chamber, and so cooled the air of the chamber about 10° F.

Messrs. R. A. Rowlands and H. B. Walker have carried out, with us, numerous experiments in this chamber. They have performed measured amounts of work (raising a weight) under varying conditions of temperature moisture, and with varying percentages of O_2 and CO_2 in the chamber.

As a measure of the exhausting effect of the work, we have counted the frequency of the heart-beat in the first, second and third minute after the completion of the work. When the work is done without over-fatigue the frequency of the pulse, which is accelerated by work, quickly returns to normal. Our results show that increased percentages of CO_2, and diminished oxygen percentages of 2 per cent. to 3 per cent. and even 4 per cent. to 5 per cent., have little effect in modifying the frequency of the pulse, while the temperature and humidity of the air have a profound effect. The feelings of discomfort depend on the excessive heat and humidity, and are relieved by cooling and whirling the air in the chamber. If we suddenly raised the percentage of CO_2 in the chamber up to 2 per cent. we found the subjects inside were quite unaware of this. If we sat outside and breathed through a tube the air in the chamber we felt none of the discomfort which was being experienced by those shut up inside. Similarly, if one of those in the chamber breathed through a tube the pure air outside he was not relieved. Similar experiments were carried out by Paul, and with like results. The cause of the discomfort is thus proved to be due to the excessive heat and humidity, and absence of movement of the air. Studying the

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ventilation of sleeping-cars, T. R. Crowder finds that in these cars, called "close" or "stuffy," the temperature invariably is high. There has sometimes been an unpleasant odour. A high temperature renders this more noticeable. The most marked offensiveness noticed was in a day coach, where "the air was of such a degree of chemical purity as to indicate ideal ventilation by any standard that has ever been proposed. The car was hot and had many filthy people in it." Perfect comfort has been found associated with the highest chemical impurity in other cars.

After healthy and clean students have been shut in our chamber we find there is no offensive smell in the confined air.

Ventilation cannot get rid of the source of a smell, while it may easily distribute the evil smell through a house.

As Pettenkofer says, if there is a dungheap in a room, it must be removed. It is no good trying to blow away the smell. Houses and people and their clothes and bodies must be made clean, and latrines and kitchens placed on the top of houses, or outside them, and on the windward side. There is yet another aspect of ventilation which we have not yet discussed, viz., bacterial infection. Catarrhal infections are spread by the expulsion of droplets of saliva when speaking, coughing or sneezing. During quiet respiration the exhaled breath is practically sterile, for the wet mucous surfaces of the respiratory tract catch all the inhaled bacteria, and no "droplets" are exhaled. Can we lessen the "droplet" infection by ventilation? Fluegge concludes, from the results of his admirably contrived experiments, that we cannot. He says a current sufficient to drive out such droplets cannot be borne by the inhabitants of the room. A moderate ventilation current tends to keep the droplets suspended in the air. In a still room they soon fall to the ground, and, clinging to floor and furniture, may be wiped up next morning and removed by the housemaid.

We cannot hope to prevent infection in crowded railway carriages, theatres, chapels, schools, etc. The epidemics of common colds that sweep through the community show this only too well.

It is impracticable to isolate all those suffering from colds, but we can teach them at least to cough and sneeze into a handkerchief, and perhaps even talk with a handkerchief held in front of their mouths. Above all, we must seek to keep up our immunity and resist infection. Immunity depends on the quality and flow of the blood, the supply of immunising substances in the tissue lymph, the activity of the ciliated epithelium and phagocytes which form a second line of defence against bacteria. The state of all these defensive mechanisms of the respiratory membranes are modified by the temperature and relative humidity of the air. Exposure to over-heated dry air dries up not only the skin but the membranes of the nose and throat, and so lessens immunity.

Exposure to over-heated moist air brings the blood into the skin, lessens the circulation through the viscera, and deprives us of the stimulating effect of cold on the cutaneous nerves, decreases the evaporation from the respiratory tract, diminishes the muscular activity, and so the amount of oxygen breathed in and food eaten, and thus altogether lowers the plane of our existence. Hence arise diminished health, strength, and increased susceptibility to catarrh. Those who habitually expose themselves to cold rarely take cold.

Confinement in over-heated, windless air, which too often pervades places of business and amusement, is one of the chief causes of the depressed physical and mental vigour of town dwellers. The evidence of daily life proves that those who take hard exercise in the outside air for some hours a day escape these ill effects. The health of sailors and country labourers shows us that sleeping in hot, confined and ill-ventilated quarters is of no consequence if the working day is spent in the open air. It is persistent exposure to the uniformity of warm, windless air which is the cause of the mischief. The conditions of great cities tend to confine the worker in the office all day, and to the heated atmosphere of the club, cinema show, or music-hall in the evening. The height of the houses prevents the town dweller from being blown upon by every wind of heaven, and, missing the wonderful exhilaration of the cool, moving, open air, he repels the dull uniformity of his existence by the moving pictures of the showman and by tobacco.

We have now dealt with the general principles which ought to control the practice of the heating and ventilating engineer. The old English methods of open fire and open window have very much to recommend them. By the open fire air is kept moving and cool air is brought in; the heating is by radiation, and uniformity of the conditions of temperature in the room is prevented. On the other hand, the

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impulsion of hot air into a room is the most objectionable of all the systems employed. A cool air and radiant heat are the ideal; the hot-air system give us neither. In cold weather the heated air becomes excessively dry. The vigour and health of children in America have been seriously undermined by the impulsion of hot "desert air" into the schools.

We are now in a position to examine the uses of ozone in ventilation. Ozone is represented by O_3, and differs from the oxygen molecule, O_2, by the addition of a third atom of oxygen, which is loosely bound and has powerful oxidising properties. It corrodes cork, rubber, and other organic substances, and oxidises iron, copper, and even silver when moist, and dry mercury, and iodine. Galvanised iron tubes or glass can be used for the conductance of ozonised air. Traces of ozone are found in the atmosphere after thunderstorms, produced by the effect of the electric discharge on atmospheric oxygen. It is said that traces of ozone exist in sea and mountain air. Ozone is generated by the silent discharge of high-tension currents from one plate of metal to another across a sheet of insulating material. In the Ozonair apparatus demonstrated by us the metal plates are sheets of fine gauze separated by micanite. The discharge takes place from the multitude of points on the gauze, and this equalises the tension at which the discharge takes place, prevents sparking and the formation of oxides of nitrogen. These oxides contaminate the ozone which is formed when ordinary smooth plates are employed, for the discharge then takes place at a few rough points at a far higher tension and with sparking. It is said to be the sparking discharge in air which causes the oxides to form. Each complete element of the Ozonair apparatus consists of a thin sheet of micanite, covered on each side by a square of gauze. The air can be made to pass by a series of baffle plates over a series of these elements. There are over 230,000 round projections to the square foot of the gauze, from which discharge takes place. The gauze is made of an aluminium alloy of forty meshes to the inch.

The Ozonair Company have placed their apparatus at our use, and we must thank Mr. Edward L. Joseph for his courtesy and assistance in the carrying out of our inquiry. The concentration of ozone can easily be determined by aspirating a 10 litre sample of the air through an acidulated 1 per cent. solution of potassium iodide. A little fresh starch solution is added to this. The ozone turns it blue. Titration is carried out with a standard solution of hyposulphite of soda.

On exposing mammals to different concentrations of ozone in our chamber, we have found they may be killed by prolonged breathing of concentrations of about twenty parts per million. The cause of death is an acute irritative inflammation of the respiratory tract. After death congestion of the lungs is found. The ozone in such concentrations causes the eyes to water and makes one cough. It is so irritative and unpleasant that no one would think of continuing to breathe it. Thus a man cannot be poisoned unawares by a dangerous concentration of ozone. He will certainly remove himself from its presence. No harm results from breathing such concentrations for a short period. A slight irritation of the respiratory tract and some sneezing and coughing, and perhaps headache, are the only penalties. The danger signals are clearly set by ozone, and anyone must naturally obey them. When ozone is employed in ventilation it is arranged in such a concentration as to produce none of these symptoms of irritation.

Oxygen in high concentrations (at two or three atmospheres of pressure) is also a poison, and produces not only acute congestion of the lungs but convulsions. Unlike ozone, oxygen produces no preliminary irritative effect. The breathing of ozone in suitable weak concentrations is no less safe than the breathing of proper concentrations of oxygen. Certain insects are comparatively immune to the effects of high concentrations of ozone. For example, we have found that fleas stand exposure to about one hundred parts per million for five hours. This is very unfortunate. Had these parasitic insects only proved highly susceptible we should have found in ozone a clean and ready method of attack.

Ozone can be used in high concentrations for sterilising water; and herein is to be found one of its most valuable uses. The water is not only sterilised but oxygenated, and ozone can be used, therefore, with great advantage to keep the water of aquaria in good condition. Ozone has been successfully applied as the means of purifying the water-supply of several towns, both abroad and in this country. Where the water-supply is contaminated and the source of electric power is cheap, no better or simpler method can be employed. Ozone is a most powerful deodoriser. It takes away all disagreeable smells. Whether it destroys them or prevents the nose smelling them, is of little importance. The psychical effect is the same—

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the disgust due to the evil smell disappears. Ozone itself has a peculiar smell. It reminds one of the fumes of nitric acid, and whether the smell is that of ozone or minute traces of oxides of nitrogen, it is difficult to say. The nose may detect what the analytical methods of the chemist fail to show. By the smell we can detect concentrations of far less than one part in a million, and the smell is the safest and easiest guide to a suitable concentration. Ozone should be present in the air for continuous breathing in concentrations not greater than that scarcely perceptible to the smell. Concentrations of even one part in the million are too irritative, and quickly depress the metabolism and lower the temperature of rats, and are unpleasant to man. Very weak concentrations, barely perceptible to the smell, have no ill effects, but destroy the effect of unpleasant smells and give a certain tang or quality to stuffy air which relieves its monotony and uniformity.

It is in this respect that ozone has its use. There exist in modern conditions of life so many trade shops, tube railways, cold meat stores, etc., where the employees are exposed to a persistent, uniform and depressing smell. The air in many buildings is made to smell by the heating appliance used. The addition of ozone takes away the smell and relieves the monotony of such air, and, as the Ozonair apparatus can, by the turning of a switch, be put in or out of use, the uniformity of the atmospheric conditions can thus be frequently changed. The ozone, no doubt, exerts its effect both on the cutaneous and respiratory nerves.

We have not been able to obtain any evidence that ozone in weak concentrations influences the respiratory metabolism of the resting man. We have studied the effect of ozone both on animals and on ourselves, estimating the amount of oxygen used up and carbonic acid produced during successive periods of time when air or ozonised air was breathed.

The rate of oxidation of the human body is set by the nervous system, which controls the activity of the body. Breathing pure oxygen in place of air has no effect on the metabolism of the man at rest. It will increase the metabolism of a man doing hard work, but only in the case of his working so hard that he suffers from a shortage of oxygen when breathing air. The body, unlike a fire, cannot be fanned up to burn faster. The living substance works at its own rate independent within wide limits of the changing conditions of the outside world. We should not expect, therefore, that ozone would stimulate the metabolism of the resting man. By altering the unpleasant uniformity of a close atmosphere it may help an employee to work more briskly. In high concentrations, ozone, just as high concentrations of oxygen, depresses the metabolism because it is toxic to the cells of the respiratory tract. The ozone which is breathed into the lungs is caught by the wet mucous membranes and none of it is exhaled. It is, no doubt, used up there in an oxidative process of the tissues. It is excess of such oxidative process which damages the cells lining the respiratory tract, when either too great a concentration of ozone (or oxygen) is breathed. There is no evidence that ozone reaches the blood, or that it has any other influence on the body. The effect which ozone in weak concentrations has on the olfactory nerves, and those of the skin and respiratory tract, is the justification for its use in ventilation.

It seems to us that the addition of ozonised air to the Central Tube Railway has improved the conditions there. The unpleasant characteristic smell of the Tube has been diminished, and the monotonous quality of the air improved.

DISCUSSION.

The Chairman (Lord Sanderson), in opening the discussion, said the audience was very much indebted to the authors for the strikingly original way in which they had explained scientifically a good many things he had not understood. They had explained why people had been very frequently comfortable under certain circumstances, when they were scientifically informed that they ought to be very much the reverse; and why they had frequently suffered a great deal of discomfort when much trouble had been taken to make them comfortable. Personally, he was not competent to discuss the subject scientifically, but he wished to offer a few unscientific observations which confirmed the authors' views. He remembered, about thirty years ago, going for a long drive in a closed landau in company with a venerable peer and two ladies who were almost his contemporaries. Snow was on the ground at the time and there was a hard frost. When the drive commenced the old gentleman said, "What are we to do about the windows? My experience is that it is always better on these occasions to keep them shut until they get clouded over, and then drop the windows a bit and let in a stream of cold air." That plan was carried out, and none of the party caught any colds. The committee rooms of the House of Lords were most scientifically ventilated, but he confessed that in March, when sitting in those rooms, he always longed to be allowed to sit in his robes, while in midsummer he would prefer to be dressed in an Indian shawl and a sash. In July, two or

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three years ago, he remembered an occasion when all the windows in one of the committee rooms were fully shut, and the electric fans were working as hard as they could, pumping hot air out of the room. Counsel, who were dressed in wigs and gowns, and some of whom were of majestic dimensions, felt the heat very much, and their tempers became extraordinarily short. At last, notwithstanding the protest of the engineer, he ordered all the doors and windows to be opened; and the effect, both morally and physically, was quite remarkable—it was beneficial to the highest degree. After that he began to think what it was that constituted the great advantage of fresh air, and he came to the same conclusion as the authors. In the first place, it was fresh instead of being cooked; and, in the second place, it came in in little gusts at different temperatures, in different directions, and with different force. His own idea of the perfection of ventilation was that the walls of a room should be full of holes, and that outside there should be a man with a keyboard which he would play upon like an organ, thus letting in little puffs of air, there being holes in the ceiling to carry away the bad air, but he was afraid his plan was not practicable. Everybody had a different idea of what was an agreeable and wholesome temperature; in fact, he had known a case in which the comfort of married life had been destroyed because the husband and the wife respectively enjoyed temperatures which made the other ill. In rooms where one sat for any length of time there was an absolute necessity for a little motion, even if it was only fidgetting. He had always advised friends not to write near an open window in cold weather, but to have the room heated to a little higher temperature than would otherwise be the case; but that necessity was avoided if the occupant of the room moved about to a certain extent. The late Lord Derby told him the story of a man who, to overcome the difficulty, put the blotting-pad at one end of the room and the ink-pot at the other. Nowadays, it was quite sufficient to have a telephone in the room. With regard to the question of smells, there was a French proverb to the effect that the things that smelled were not the things that killed: it was the things that did not smell that killed. That proverb had given him a great deal of consolation whenever he had been walking about the streets of some Continental towns, or travelling along the canals of Holland. It was advisable to take an ozoniser with one on such occasions. The authors had given a very clear idea of what ozone was, and what it smelt like. Some people had the most extraordinary ideas about ozone—for instance, they would insist upon walking their friends along certain ridges by the seaside where brackish sea water was covered by a green slime, which gave a horrible smell, and this they said was ozone. Personally he did not believe it was; it was the dreadful smell that was usually associated with rotten eggs.

Lieutenant-Col. Sir Charles Bedford, I.M.S., said that the authors had referred to the question of the smallest proportion of ozone which was perceptible to the senses. Hartley found that $\frac{1}{500000}$th part of ozone was perceptible to the senses. The ordinary proportion of ozone in air was something like $\frac{1}{1000000}$th of the volume of air, and it had been found that $\frac{1}{1100}$th to $\frac{1}{1200}$th of a milligram of ozone per litre constituted, for certain therapeutic purposes, an innocuous dose.

Dr. Samuel Rideal said that the authors had dealt with the theory of ventilation in a simple, straightforward manner that everyone could appreciate. It was now well known that the problem of ventilation was a question of temperature and moisture rather than of oxygen or carbonic acid. Personally, he would have been glad if the authors had given some further information with regard to the effect of ozone, if any, on the problems of ventilation. Although he had done work in connection with ozone in water, he had had no personal experience with regard to ozone in ventilation. One of the principal properties of ozone was its power as an oxidising agent; and one would think probably that the disappearance of smell when ozone was used in ventilation was its oxidising effect upon small quantities of volatile or organic matter, which seemed to be the things that caused the smell; and that oxidising effect was more rapid when ozone was present than the small oxidising effect that took place by natural oxygen. But, in addition to that point, it would have been of interest if the authors had referred to the effect of ozone on the germs which he had indicated were the things which might be present in the air of a room that might have injurious effect upon health. The authors had not, however, given any information whatever with regard to the germicidal effect of small quantities of ozone on any stray pathogenic organisms that might be present in the air of a tube or a room after someone had been sneezing, coughing, or talking. He had been in some buildings where ozone had been used for ventilation—the Lord Chief Justice's Court, for example—where he knew that unpleasant smells previously existed, and he was able to confirm what had been said with regard to the distinct improvement in the smell of a place which had been ventilated by means of ozone or ozonised air. But it was necessary to be very careful in dogmatising upon its effect, because in those places where ozone ventilation had been introduced the method adopted had had a double effect, the ventilation itself having been changed in addition to the introduction of ozone. It was very difficult to tell under those circumstances how much of the improvement was due to the modification of the ventilation *per se* without the ozone, and how much was due to the additional effect of the ozone in changing the ventilation. As the authors had pointed out, lack of uniformity was essential to comfort, and such

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changes in the quality of the air could be brought about by ordinary ventilation, by bringing in the fresh air in gusts, or by means of puffs from an organ outside. It would, therefore, be interesting to know how much of the improvement in the places referred to was due to the ozone, and how much to the change of the method of ventilation.

Mr. Edward L. Joseph said that, so far as his own experiments had gone, they went to prove the absolute falsity of the figures given by Sir Charles Bedford with regard to the percentage of ozone in the air. From the figures given it would appear that on the average there were ten parts in a million of ozone in the atmosphere, but, personally, he thought it would be more correct to say there was only one part in a thousand million present. In reply to Dr. Rideal's remarks, he wished to say that a test was invariably made in all the installations of ventilation, both with and without the ozone, and it was easy to gauge the effects. Some very striking examples of the improvement in ventilation due to the use of ozone had come within his own personal knowledge in hide and skin warehouses, and other places where unpleasant occupations were carried on.

Dr. Martin Flack confirmed Mr. Joseph's remarks with regard to the absolute absurdity of the figures given by Hartley. Experiments had been carried out on some rats in a glass bell-jar into which ozone in a concentration of one per million had been injected; while in another bell-jar by the side rats were placed, and no ozone was injected but simply the air from a fan. The temperatures of the animals were taken before the experiment, and it was noticed that when the ozone was turned on that their metabolism was depressed, while at the end of a certain number of minutes their temperature had fallen. In the meantime the animals put up their fur, kept very still, and showed every sign of discomfort. He knew from his own experiments that Hartley's figures were altogether wrong, and the figure Mr. Joseph had given was probably correct. With regard to the question of uniformity, it was possible in a system of ventilation to turn the ozone on and off, and thus obtain that lack of uniformity which was so essential to good ventilation.

Mr. F. W. Jennings thought the authors had not laid sufficient emphasis on the connection between heating and ventilation. It had always been considered by ventilating engineers that the ventilation of a building could not be satisfactorily dealt with unless the heating was considered at the same time. The authors had not said very much on that question, although they mentioned that the most satisfactory rooms from the heating and ventilating point of view were those dealt with by open fires. He quite agreed in that remark, but, unfortunately, open fires were not applicable to many rooms. The most satisfactory rooms with artificial central heating that he had seen were in some schools that had recently been built in Staffordshire, which were arranged with open windows on two sides, but with an abnormally large amount of heating surface for the radiators; in fact the system appeared to be that the rooms were made so exceedingly hot that it was necessary to have the windows open. In such rooms as assembly halls, very satisfactory results had been obtained by keeping the temperature of the heating surface down. Some of the best installations he had seen were in cases where the rooms had been heated by direct heating radiators independently of the ventilation, a small amount of heat being added to the air to bring it to approximately the same temperature as the room. Consequently the temperature of the air in the room could be varied independently of the heat of the room itself. The air was passed over steam coils at an exceedingly low temperature, the temperature of the heated surface not exceeding 180 degrees. That system appeared to prevent a great deal of the unpleasant dryness or scorching of the atmosphere. Both the temperature and the humidity were automatically controlled. That system was very satisfactory for assembly halls in which the people stayed for only a comparatively short period of time, but he had not yet discovered any really satisfactory system of mechanical ventilation for rooms such as offices in which the occupants stayed the whole day. He thought the authors had struck the right note when they pleaded for a change of uniformity. As a ventilating engineer he welcomed the paper very much indeed, because if such engineers were clearly told the requirements that scientific gentlemen insisted upon they would undertake to fulfil them. He did not think, however, that ozone was the only thing to be considered, because it would have been impossible to blow cold air into rooms during such weather as had recently been experienced; it was essential that the chill should be taken off it.

Mr. J. H. Vincent said the authors had pointed out the evil effects of highly moist atmosphere. It would be of interest, he thought, if the authors stated whether it was not advisable to prevent air from being supplied too dry.

Mr. E. P. Grove said the Central London Railway Company had realised that the air on the Tube was not exactly what it should be, and had, therefore, expended a very large sum in installing an ozone ventilating system, by means of which the quantity of air put into each station would ultimately be about 8,000 cubic feet per minute. The ozone portion of the system formed a distinct feature; but he had noticed that it was sometimes difficult to tell whether the ventilation plant was at work unless it was possible just to smell the ozone. He thought it was the general opinion that the air on the Central London Tube was greatly improved; in fact, he did not think it could be very much better on a tube railway, in

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view of the particular conditions under which tube railways had to work.

MR. F. A. WILLCOX said that, as he had had some experience with carbonic acid and ozone, he fully appreciated the authors' remarks with regard to the effect of carbonic acid, and the quantities it was possible to breathe. He had worked on one of the carbonic acid collecting plants in the vats of a brewery, where, instead of the gas being put into the bottles, about 500 lbs. of the gas was being blown into the atmosphere per hour. He noticed that so long as he stood still there was no appreciable effect; but if he tried to run up a ladder, or go from one end of the room to the other, he got out of breath, just in the same way as he would do in making a hundred yards' sprint. He was rather disappointed that the authors had not given more information with regard to the germicidal effect that ozone had, because he gathered from the paper that the principal injurious agents in the atmosphere were the bacteria and the organic matters which were exhaled by human beings. If ozone had some effect in that direction it would probably be very advantageous. He desired to ask the authors also whether they were perfectly sure that the oxides of nitrogen were got rid of in the apparatus used. It was also well known that the unsaturated fats had a great affinity for ozone. He had noticed himself that a fairly concentrated atmosphere had an irritating effect on the skin; and it would be interesting to know if the authors had carried out any experiments in that direction.

DR. LEONARD HILL, in reply to the questions that had been asked with regard to ozone and germs, said that in weak concentrations such as it was possible for human beings to breathe without any injurious irritation to the respiratory tract, the ozone could not be expected to influence the germs. The germs, or bacteria, were structurally capable of much more resistance than a human being's sensitive mucous membrane. There was a great deal of error broadcast in the minds of some people, who thought it was possible to take into the lungs, or any part of the body, some kind of antiseptic solution which would kill a germ and not kill a human being. That was not the case. It would kill the human being much more readily than the germ. Concentrated ozone had been passed over the top of culture fluids without destroying organisms like the coli bacillus. He had no evidence on the point of whether it was possible to destroy organisms by very high concentrations. If all the air was passed through the ozoniser and went through the plates, he was not in a position to say how far that would sterilise it; the subject required careful bacteriological examination. With regard to the question of the oxides of nitrogen, many physiological tests were far more sensitive than chemical tests. Physiologists and bacteriologists dealt with solutions which could not be dealt with by the balance and chemical methods. He had demonstrated some things by biological tests which could not be detected at all by chemical tests. It was possible that, all the time, there were in the ozone traces of oxides of nitrogen, and that the irritating effects were due to that cause. He had not yet carried out the experiment of trying to get rid of the oxides of nitrogen, and the suggestion made by Mr. Willcox with regard to that matter was a very valuable one. In reply to Mr. Vincent's question, the air could be made too dry, and it was then just as bad as being too moist. During the excessively cold weather in America the air was heated to 100° F., or 120° F., and then driven into the schools. The air outside might be saturated with moisture to 20° below zero, but when it was heated up to 120° F. it was nothing but dry, desert air, which wetted itself against the bodies of the children, took all the moisture out of their skins, lessened their vigour, lessened their immunity to diseases, and made them very miserable. He believed very dry air was the worst thing possible for respiratory diseases. So far as the Central London Tube was concerned, he thought its ventilation had been very greatly improved by the introduction of ozone. The smell was very much less, the air was pleasanter in every way, and the old uniformity had been changed. He thought the right plan to adopt was for the ozone to be just perceptible to the smell. He quite agreed with the speaker who mentioned that there was no better method of ventilation than that adopted in the Staffordshire schools, where there was plenty of radiant heat and open windows. The ideal method to aim at was to get the cool air from outside, and to have radiant heat.

THE CHAIRMAN, in proposing a cordial vote of thanks to the authors for their interesting paper, said there was one thing they drew attention to which ought to be borne in mind, namely, that the law of nature was infinite variety, and that the bane of most human systems was the attempt to obtain uniformity in circumstances which were not uniform. Although he was not an anti-vivisectionist or a vegetarian, he thought thanks should be accorded to the authors also for the flourishing condition of health their guinea-pigs exhibited, in spite of their experiments; in fact they were so humane that they did not even kill fleas.

The resolution of thanks having been carried unanimously, the meeting terminated.

CORRESPONDENCE.

RADIO-TELEGRAPHY.

I fully agree with the remarks made by Professor G. W. Osborn Howe, following on his valuable paper, in regard to the strategic aspect of wireless telegraphy, and, as evidence of the same conclusions

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being arrived at by myself independently, I should like to quote the following from my article on "Telegraphic Communications and the Empire," published in the *Empire Review* last December :—

"Let us now consider the services which wireless telegraphy can perform in the interests of the British Empire. This branch of applied science has developed in an altogether wonderful way; and, thanks largely to the business ability and enterprise of Mr. Marconi and his companies, it has already achieved much. It is some years ago now since I urged for wireless telegraphy being turned to account—on trial at any rate—as an auxiliary to cables throughout the Empire, whilst also pointing to its application for coast communication and general maritime uses. Since then, Mr. Marconi, by dint of enormous perseverance in various directions, has established a regular trans-Atlantic wireless service. Here he has been brought into competition with rival cable companies affording an excellent service of long standing; and if a comparison be made between the trans-Atlantic cable service and the trans-Atlantic wireless service it cannot at present be claimed that the latter seriously approaches the former in point of efficiency, though having the advantage in the matter of cost.* It only remains to be said the wireless system has so far been materially handicapped by the fact that, unlike the cable services, it has not had satisfactory land-line connecting links on the other side. But whilst this accounts for the comparatively small number of trans-Atlantic messages sent by the wireless system, and also, to some extent, for the comparatively long time occupied by those which are sent, it does not serve as an explanation for those radio-telegrams which never reach at all or for the errors on others . . . ."

"Apart from the superiority of the cable service in accuracy, speed and even certainty of reception, it has a distinct advantage over the wireless system —amongst those that know both—as a stragetic asset. Wireless telegraphy is of considerable value to the Navy—as well as generally—in times of peace, when the operators on seeing a message is not for them leave it alone; but that sort of consideration for others, and the property of others, would scarcely prevail if trouble were in the wind or when actual war was proceeding. Under such conditions everyone would be picking up everybody else's messages and making what could be made of them, besides disturbing them where possible. In this way, wireless telegraphy would be likely to prove a two-edged weapon, indeed. Another point that requires consideration is the fact that all wireless stations having masts and aerials—more or less high—form a handy target for the enemy. Whatever provision may be made to meet this objection, it cannot be gainsaid that a wireless station is liable to be a far more vulnerable object than a deep-sea cable. Then again, whilst radio-telegraphy can be carried on fairly satisfactorily in temperate zones, that is not so in the tropics, and 'atmospherics' are, as yet, always a source of more or less trouble, often stopping operations for several hours on end. These are, indeed, serious objections to the movements of a fleet being directed from headquarters by 'wireless'—especially where a number of re-transmissions have to be accomplished. Further, we may have to battle with the demoralising influence of any untuned system—such as that on the Eiffel Tower—within, say, a range of 1,000 miles."

Caxton House, Westminster. CHARLES BRIGHT.

* On this account it should serve as a lever for bringing down cable rates.

ILLUMINATED MANUSCRIPTS.

I read with the greatest interest Mr. Davenport's paper on "Illuminated Manuscripts," and the discussion which followed. I hope it will not be deemed presumptuous of me if I venture to differ from Sir William Armstrong in his remarks as to the ease of carrying out interlacements in metalwork correctly. In my experience, as long as the pattern simply consists of plaitwork, or the interweaving of several strands with free ends, wirework is fairly plain sailing; but when a single strand has to be doubled and interlaced on itself it is quite a different matter, and a long time may sometimes be spent in arranging the proper alternating "overs" and "unders" if the design is at all elaborate.

I speak from practical experience, having long been enamoured of Celtic metalwork, and having carried out many pieces of jewellery in which interlaced wirework has been a prominent feature. I have, however, never succeeded in attaining anything remotely approaching the almost incredible intricacy of some of the Celtic interlacements. I *may* some day, but in the meanwhile I find it sadly easy to "go wrong" in the attempt. It is very interesting to try to carry out some of the patterns on a large scale with the soft lead wire used for horticultural purposes. It is very pliable and, if not often bent too sharply, does not break easily. But even with this soft material, and on a scale so much larger than the original, the attempt to follow out even a fairly simple pattern is apt to make me feel very humble when I compare the often "worried looking" result with the straightforward achievements of the old-time craftsmen.

I do not know how hard it may be to keep an interlaced pattern right in an illumination. I have never tried. But I am quite convinced that it is very far from "difficult to make it wrong in metalwork." MACIVER PERCIVAL.

THE OLD DISTRICT RECORDS OF BENGAL.

Mr. Firminger's paper, published in the *Journal* of the 2nd inst., has aroused widespread interest in the old Bengal records. These are of the utmost importance. May I be permitted to suggest that

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one of the many Government offices, which, under the new arrangements consequent on the change of capital to Delhi, will be vacated in Calcutta, should be used as a central Bengal Record Room for all records of the Province older than 1793, the date most approximately marking the end of the heroic period of revenue administration in Bengal? This bringing together of the now scattered relics of the olden days, in what must still and always remain "the premier city," would be a most desirable step in the direction desired by Sir Steuart Colvin Bayley and other speakers, of assuring their future security and accessibility to students and historians for research purposes.

Failing Calcutta, to my mind Whitehall should house all these documents, rather than they should be left to their present unsatisfactory chances of permanent preservation.

WILMOT CORFIELD.

OBITUARY.

HENRY TAYLOR BOVEY, M.A., LL.D., D.C.L., F.R.S.—Dr. Henry Taylor Bovey, formerly Rector of the Imperial College of Science and Technology, South Kensington, died at his residence in Eastbourne on the 1st inst.

Dr. Bovey was born at Torquay in 1852. After being educated at a private school he proceeded to Queens' College, Cambridge, and graduated as Twelfth Wrangler in the Mathematical Tripos in 1873. He was shortly afterwards elected a Fellow of his College. Adopting the profession of a civil engineer, he joined the staff of the Mersey Docks and Harbour Works, of which he was soon appointed assistant engineer. In 1887 he went to Canada, on his appointment to the Chair of Civil Engineering and Applied Mechanics at McGill University, Montreal. At this time the engineering courses of the university were managed as a branch of the Faculty of Arts, and it was mainly owing to Dr. Bovey's advice and energy that a new department of Applied Science was created, which has developed into one of the most important and successful branches of the university.

In May, 1909, Dr. Bovey was recalled to this country, having been appointed the first Rector of the Imperial College of Science and Technology, but, unfortunately, his health broke down, and he was compelled to resign in the following December.

Dr. Bovey was LL.D. of McGill and Queen's Universities, and D.C.L. of Lennoxville. He founded the Liverpool Society of Civil Engineers, and was one of the founders of the Canadian Society of Civil Engineers, an honorary member of the National Electric Light Association of the United States, and a Fellow of the Royal Society of Canada. In 1897 he was Vice-President of the Mechanical Section of the British Association, in 1902 he was elected F.R.S., and in 1906 his old college at Cambridge made him an honorary Fellow.

Dr. Bovey joined the Royal Society of Arts in 1907. Two years later he was elected on to the Council, on which he continued to serve up to the time of his death.

NOTES ON BOOKS.

SHOULD WE STOP TEACHING ART? By C. R. Ashbee. London: B. T. Batsford. 3*s*. 6*d*. net.

The place of art in the modern industrial system, and public art education generally, are questions which have been before us of late years in one or other of their aspects; and at a time when the Royal College of Art and the art schools throughout the country are the subject of inquiry and report by a departmental committee, Mr. Ashbee's critical examination of the present system of art teaching, and his practical proposals for its reconstruction so that art can take its proper place under modern economic conditions, are both interesting and suggestive.

No one who has once grasped the sad significance of the Royal College statistics as presented in the committee's report, can pretend that the present method of fostering art by scholarships and endowments is at all satisfactory. In a period of ten years 429 students were trained at the Royal College; of these only thirty-two have made the practice of art in any form their livelihood, while 126 earn their living as teachers. In view of these figures, Mr. Ashbee's titular question can hardly be answered offhand, unless in the affirmative. In short, the supply of trained art-workers has far outrun the demand, for the public, if it wants their work at all, only wants it for a price at which they cannot produce it and live; so that at present it is only at the expense of the artist that we can make good works of industrial art accessible to the average man. Mr. Ashbee cites newspaper illustration among the few cases—such as architecture, etc.—in which economic independence has not been undermined by machinery; but surely even here photography threatens the artist's pen.

If we want the arts, then, we must somehow enable them to meet the conditions of our time, make it possible for them to compete against the machine, and protect them against its unfair competition. These things Mr. Ashbee would do by a sort of art bounty, by starving out machinery, when wrongly applied, by means of a State subsidy to good work. Much of the money now spent in futile teaching he would like to see spent in the endowment of artistic workshops, where apprentices might learn their craft, and he rightly urges that by so doing we should "endow skill, invention and imagination," instead of as at present stimulating them artificially in schools and then checking them unnaturally in life. After a detailed consideration of the various educational, agricultural, and other issues involved by his proposed reforms, Mr. Ashbee comes to the constructive aspect of

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his subject, and outlines his scheme for the transformation of the art school system of the country into a guild system of associated workshops. His wide and varied experience—artistic, educational, administrative and architectural—ought at least to secure for his views the careful consideration of the authorities.

GENERAL NOTES.

THE VINTAGE OF 1911 IN FRANCE.—The *Moniteur Vinicole* states that the result of vintage in France during 1911 shows a great improvement on that of 1910, which was an exceptionally bad one. It estimates the total production of wine of Continental France, the island of Corsica, and the colony of Algeria, in 1911, as compared with the previous year, to be as follows:—

	1910. Hectolitres.	1910. Gallons.
France . . .	28,529,964	627,659,208
Corsica . . .	143,086	3,147,892
Algeria . . .	8,414,654	185,122,388
Total . .	37,087,704	859,929,488

	1911. Hectolitres.	1911. Gallons.
France . . .	46,776,000	1,029,072,000
Corsica . . .	160,000	3,520,000
Algeria . . .	8,500,000	187,000,000
Total . .	55,436,000	1,219,592,000

THE EXPORT OF EGGS FROM EGYPT.—Hens' eggs are now exported in considerable quantities from Egypt during the winter months—that is to say, from November to March. They are shipped principally at Alexandria. During last winter no fewer than 83,608,000 eggs, to the value of £125,000 sterling, were exported. Of this number, 74,000,000 were sent to England, 3,037,000 to France, and the remainder to other countries. The eggs are comparatively small in size, but the prices are proportionately low.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

FEBRUARY 14.—CECIL THOMAS, "Gem Engraving." SIR ARTHUR JOHN EVANS, D.Litt., LL.D., F.R.S., will preside.

FEBRUARY 21.—FRANK WARNER, "The British Silk Industry and its Development since 1903." SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

FEBRUARY 28.—H. A. ROBERTS, M.A., Secretary of the Cambridge University Appointments Board, "Education in Science as a Preparation for Industrial Work." PRINCIPAL SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., will preside.

MARCH 6.—T. THORNE BAKER, "Some Modern Problems of Illumination: The Measurement and Comparison of Light Sources."

MARCH 13.—PROFESSOR ERNEST A. GARDNER, M.A., "Greek Sculpture."

MARCH 20.—F. MARTIN DUNCAN, "The Work of the Marine Biological Association."

MARCH 27.—THEODORE E. SALVESEN, "The Whaling Industry of To-day."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 25.—WALTER SAISE, D.Sc., M.Inst.C.E., Hon. Member Institute of Mining and Geology, India, A.R.S.M., V.D., "The Coal Industry and Colliery Population of Bengal."

MAY 16.—NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MAY 7.—ALAN BURGOYNE, M.P., "Colonial Vine Culture."

MAY 21.—THE HON. J. G. JENKINS, "Australian Railways."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." Three Lectures.

Syllabus.

LECTURE II.—FEBRUARY 12.—The Sheep and its Products.

LECTURE III.—FEBRUARY 19.—The Pig and its Products.

LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

February 26, March 4, 11.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

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Charles Bright, F.R.S.E., M.Inst.C.E., M.I.E.E., "The Administration of Imperial Telegraphs."

Harold Cox, "The Interdependence of Morals and Economics."

E. D. Morel, "British Rule in Nigeria."

Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

George Fletcher, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

Monday, February 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Loudon M. Douglas, "The Meat Industry." (Lecture II.—The Sheep and its Products.)

Royal National Pension Fund for Nurses, at the Royal Society of Arts, John-street, Adelphi, W.C., 3.30 p.m.

Post Office Electrical Engineers, Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 5 p.m. Mr. A. W. Martin, "Economics of Telephone Transmission."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. Arthur R. Ling, "Malting." (Part II.)

Sanitary Engineers, Institute of, at the Royal United Service Institution, Whitehall, S.W., 8 p.m. Messrs. Albion H. Scott and F. C. Davies, "Hospitals and Sanitoria and their Relations to Tuberculosis."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. (Graduates' Lecture.) Dr. T. E. Stanton, "Recent Researches at tne National Physical Laboratory."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. P. Waterhouse, "Bridges."

Tuesday, February 13...Sociological, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.15 p.m. Dr. C. W. Saleeby, "National Eugenics and National Insurance."

Moral Education League, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m.

Asiatic, 22, Albemarle-street, W., 4 p.m. Sir Charles Eliot, "The History and Monuments of Cambodja."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture V.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by Mr. D. C. Leitch, "The Water-Supply of the Witwatersrand"; and by Mr. E. C. Bartlett, "Investigations relating to the yield of a Catchment-Area in Cape Colony."

Photographic, 35, Russell-square, W.C., 8 p.m. Annual General Meeting.

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Lieutenant-Colonel J. H. Patterson, "Travel and Sport in East Africa."

Horticultural, Vincent-square, Westminster, S.W., 2.30 p.m. Annual General Meeting.

Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Professor H. G. Greenish and Miss Dorothy J. Bartlett, "The Powdered Gentian, Nux Vomica, and Ipecacuanha of Commerce."

Wednesday, February 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Cecil Thomas, "Gem Engraving."

Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m. Mr. H. R. Hall, "An Archæological Journey in Crete."

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Mr. G. F. Barrett, "Causes of Failure in Ball Bearings."

Japan Society, 20, Hanover-square, W., 8.30 p.m. Mr. S. Dick, "The Kano School of Painting."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Professor M. A. Gerothwohl, "Alfred de Vigny and his Relation to English Pessimists."

King's College, Strand, W.C., 5 p.m. (Lectures on Christian Art.) Professor W. R. Lethaby, "The Classic Age of Byzantine Art and the Architecture of Justinian."

St. Paul's Ecclesiological Society, Chapter House, St. Paul's, E.C., 8 p.m. Mr. P. H. Hepburn, "Romanesque Churches of France." (Part II.)

Thursday, February 15...Cyclists' Touring Club, Metropolitan District Association, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. A. C. Mylam, "The Ups and Downs of Five M.D.A. Members in the West Country."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Mr. R. H. Compton, "An Investigation of the Seedling Structure in the Leguminosæ." 2. Mr. C. E. Salmon, "An Abnormal Orchis from the Surrey Downs." 3. Mr. H. Findon, "Sponges from Japan."

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Captain A. St. John, "Control during Adolescence."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. B. Power and H. Rogerson, "Chemical Examination of Scammony Root and of Scammony." 2. Messrs. A. McKenzie and G. W. Clough, "Experiments on the Walden Inversion. Part VIII.—*a*-Amino-*a*-phenylpropionic Acids." 3. Mr. P. Neogi, "Preparation of the Nitrites of the Primary, Secondary and Tertiary Amines by the Distillation and Sublimation in a Vacuum of Concentrated Solutions of Mixtures of the Hydrochlorides of the Bases and Alkali Nitrites." (Part I.) 4. Messrs. P. C. Ray, J. N. Rakshit and R. L. Datta, "Nitrites of the Mercurialkyl- and Mercurialkylarylammonium Series." 5. Messrs. P. C. Ray and J. N. Rakshit, "Nitrites of the Alkylammonium Series. Part IV. — Isobutylammonium Nitrite, Diethylammonium Nitrite, Dipropylammonium Nitrite, and Tripropylammonium Nitrite, and their Decomposition and Sublimation by Heat." 6. Messrs. M. O. Forster and J. H. Schaeppi, "Perhalides of Diphenyliodonium Iodide."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. M. H. Spielmann, "The Portraiture of Shakespeare." (Lecture I.)

Camera Club, 17, John-st., Adelphi, W.C., 8.30 p.m. Mr. E. Fowles, "Great Composers of the Nineteenth Century." (With musical illustrations.)

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 8 p.m. 1. Mr. C. O. Bannister, "On the Theory of Blast-Roasting of Galena." 2. Mr. A. T. French, "Quick Combination Methods in Smelter Assays." 3. Mr. H. K. Picard, "A Graphic Method of Illustrating the Results of Extraction Tests."

Friday, February 16...Royal Institution, Albemarle-street, W., 9 p.m. Sir John H. A. Macdonald, "The Road: Past, Present and Future."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. W. T. Douglass, "Works for the Prevention of Coast-Erosion" (Vernon-Harcourt Lectures).

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Annual General Meeting.

Saturday, February 17...Royal Institution, Albemarle-st., W., 3 p.m. Sir Alexander C. Mackenzie, "Franz Liszt" (Centenary). (With musical illustrations.)

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Journal of the Royal Society of Arts.

No. 3,091. VOL. LX.

FRIDAY, FEBRUARY 16, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 19th, 8 p.m. (Cantor Lecture.) LOUDON M. DOUGLAS, F.R.S.E., "The Meat Industry." (Lecture III.)

WEDNESDAY, FEBRUARY 21st, 8 p.m. (Ordinary Meeting.) FRANK WARNER, "The British Silk Industry and its Development since 1903." SIR GEORGE BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, February 12th, MR. LOUDON M. DOUGLAS, F.R.S.E., delivered the second lecture of his course on "The Meat Industry."

The lectures will be published in the *Journal* during the summer recess.

EXAMINATIONS.

The Council of the Society are much gratified at being able to announce that the London County Council Education Committee have consented to undertake, this year and in the future, the entire supervision of the Society's Examinations in the County of London. This will involve certain modifications in the usual arrangements, and some concentration of the smaller centres.

The forms of application for examination papers, together with the fees, must be returned to the London County Council Education Office not later than February 20th. Shortly after the forms have been received by the Council, tickets for all candidates, showing where they are to sit for examination, will be sent to each centre. The Council will arrange, as far as possible, for the candidates from all large centres to be examined at those centres. The smaller centres will be grouped together at convenient places. The examination papers will be sent to the Council offices, and the Council will make all the arrangements for the superintendence of the examinations. In printing the results, every centre, as now, will have the credit of all certificates gained by its candidates.

It is expected that the proposed arrangement will greatly enhance the value of the Society's certificates, and will facilitate the conduct of the examinations. Some additional cost will be involved, but for the present year this will be borne by the Society. It is probable that in future years a moderate subscription may be required from the local committees, to cover the cost of supervision.

PROCEEDINGS OF THE SOCIETY.

TENTH ORDINARY MEETING.

Wednesday, February 14th, 1912; SIR ARTHUR J. EVANS, M.A., D.Litt., LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Brown, Frank Percival, A.R.C.A., Halford House, Richmond, Surrey.

Buckley, John, "Arncliffe," Chartfield-avenue, Putney, S.W.

Hayward, Miss Florence, 4937, McPherson-avenue, St. Louis, Missouri, U.S.A.

Higgs, Arthur King, 95, High-street, Cheltenham.

Jhalawar, His Highness the Raj Rana of (Sir Bhawani Singh, K.C.S.I.), Kothi-gardens, Jhalrapatan, Rajputana, India.

Wakefield, Captain Edward William, Strickland-gate House, Kendal, Westmoreland.

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The following candidates were balloted for and duly elected members of the Society:—

Sacoom, Samuel, Axim, Gold Coast Colony, West Africa.

Wood, Sir Henry J., 4, Elsworthy-road, N.W.

The paper read was—

GEM ENGRAVING.

By Cecil Thomas.

Gem engraving is a subject of such great extent that it is necessary for me to select from a vast amount of interesting matter that which can be most suitably dealt with in a short paper, so, in accordance with my technical habits, I

Fig. 1.—Drilling a Seal by a Seal-maker.

(From the tomb of Thy at Sakkara.)

propose to deal with the technology of the art, illustrating the methods and work of the different periods. In order to avoid confusion in the use I make of the word "gem," I should say that I refer to it in its original sense—viz., an engraved stone.

The engraving can either be incised into the stone, in intaglio, and so form a seal capable of taking impressions, or can be engraved in relief to make the familiar cameo; also larger objects—such as statuettes, vases and other sculptures—can be produced by the engraver in precious stone.

The invention of gem engraving is coeval with the first dawn of civilisation, for whenever man emerged from the savage condition and realised his power of delineating line and form, then would he discover the all-important but childishly simple secret of the art of engraving gems—*i.e.*, that the many beautiful stones that lay around him, ready shaped by Nature, were easily scratched or engraved by sharp splinters of other and harder stones that in equal profusion lay ready to his hand. This rule that a hard stone will cut a softer one is the basis of the technique, the application of which has resulted in the beautiful productions for which the art is justly famous.

The earlier engravings are, therefore, on the softer varieties of stone, such as steatite, serpentine, limestone, lapis, etc., all of which can easily be engraved with a sharp splinter of flint, and we find gems engraved in this way in Egypt, Babylonia, and the Ægean Islands.

The seal form peculiar to the Babylonians, early Egyptians, and later the Assyrians, is the curious cylinder of stone having the device incised round the surface, so that when rolled on soft clay an impression in relief of the whole of the engraved surface is obtained. The engraved gems common to Egypt are in the form of scarabs—*i.e.*, the stones are carved to represent the venerated scarabaeus beetle, the flat underside of which has the device incised to form a seal. The important use of early scarabs was for funereal purposes, and they were also used as amulets.

The gems from the Ægean Islands are distinct from the Babylonian and Egyptian seals, being three and four-sided prisms, and pebbles of round and oval shape used as seals and amulets.

All the early examples show interesting points of difference in technique, but prove that the important implement used in their production was the sharp splinter of stone or chisel of metal; this stone point would invariably be a splinter of corundum or emery mounted on the end of a suitable handle and used like a chisel to incise the engraving.

We shall see that this tool was used, more or less, up to Roman times, when it was entirely superseded. I have revived this tool with the difference that I use a diamond point, and find it invaluable for engraving the delicate parts of a cameo, such as the eyes, hair, etc.

The characteristics of crude point work are exemplified in the early engravings on soft stones from Crete, where a stiffness in the lines is most noticeable, curves being broken by the straight chisel-like cuts of the tool, the V-shaped section of the cuts proving that the implement was clumsy and perhaps of metal.

All point engraving is not of this nature, for as technical skill advanced, amazingly minute

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work was produced with its aid. The best way of proving whether a gem is cut with a point is to examine with a glass the termination of the fine strokes. These should be abrupt and as deep as, or deeper than, the rest of the stroke; this is especially noticeable in the work of later

FIG. 2.—CYLINDER SEAL OF DARIUS.
(Persian. 521–485 B.C.)

Babylonia and of Assyria. There is also a tendency for the stroke to spread at the ends, owing to the repeated slipping of the tool. These are important points to remember when I come to deal with the methods of the forgers of antiques.

An astonishing feature of these early gems is the successful way in which the engravers have essayed the difficult task of drilling.

The illustration of an Egyptian seal-maker (Fig. 1) shows one method of doing this, by rolling the drill, which has a piece of quartz or corundum at the end, in the hand; the operator, being comfortably seated, holds the drill in such a position that he can maintain considerable pressure. This method would probably be used only for the softer stones.

The first great advance in the method employed is attributed to the engravers of Babylonia about the middle of the third millennium B.C., a drill revolved by means of the bow being used to hollow out the big masses of the engraving. These tools, which I shall refer to as burr drills, required to be moistened with corundum powder and oil to give a cutting edge. They opened greater possibilities to the artists who used the hemispherical drill holes to great advantage, placing them in juxtaposition and connecting the forms with the corundum point already described.

This resulted in the boldly modelled engraving so characteristic of the Babylonian cylinder seals. Its use is also seen in the shallower Assyrian work of a later period (see Fig. 2).

The vigorous treatment seen in later Babylonian work points to the use of yet another tool, a variation of the last. This we term a disc, and its value was to make a longitudinal cut; it was not used to a great extent, probably owing to the difficulty of controlling it.

It is obvious that for cutting only on the edge of the disc with the aid of corundum powder some form of bearing is required. This may have been supplied by a hollow block of wood held in the hand as illustrated in the Egyptian wall painting, or an additional bearing held by the teeth may have been employed. This method has apparently been used, and would give great control over the tool.

The only other ancient tool of importance is the tubular drill, the use of which is principally confined to the series of gems from Crete, a series contemporary with the Babylonian and Egyptian engravings, yet somewhat distinct in technique.

The importance of these island gems cannot be overestimated, and we must be grateful for the invaluable researches of Sir Arthur Evans, to whom we are indebted for their discovery and the interesting matter in relation to them.

We can trace in these gems first the use of a pointed instrument for chiselling the device in the soft steatite so plentiful in the island (Fig. 3), then the use of the burr and tubular drills. Formed from a tube of metal, the edge only of which cut with the aid of corundum powder, and revolved quickly with the assistance of the bow, the function of this tubular drill was to engrave circles and parts of circles, which would vary in size according to the diameter of the tube. The portions of circles or crescents were obtained by slanting the drill so that only a part of the edge cut the stone.

FIG. 3.—STEATITE.
(Three-sided seal. Crete. Before 2200 B.C.
In Sir Arthur J. Evans's collection.)

The results of its use are clearly seen in these examples, for which I am indebted to our Chairman, and the precision and delicacy of some of the engravings show advanced technical ability.

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As you see in the illustration (Fig. 4), there is little difficulty in picking out the cuts of the various tools. The mechanical precision of the circles is the essential feature of tube-drill engraving, a result that cannot be obtained by other means. At first this tool was used somewhat crudely, but in later times—*i.e.*, during the period of greatest Minoan development—extraordinary dexterity is shown in manipulating the drill. This is seen in the three-sided cornelian seal, beautifully engraved with Cretan hieroglyphics, in Sir Arthur J. Evans's collection (Fig. 5). The illustration shows that the eyes of the cat are formed by two circles most carefully worked into the modelling of the face. The engraving has been so carefully finished with the corundum point that the use of the drill is partly concealed. The earliest examples I have found of tube-drill work in Egypt belong to the Twelfth Dynasty,

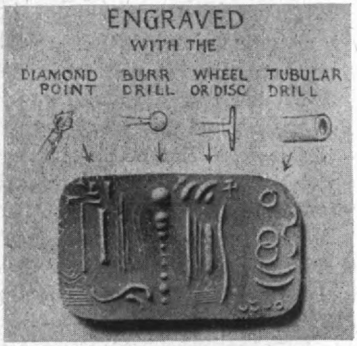

FIG. 4.—ENGRAVING TOOLS AND THEIR CUTS.

when it was used for drilling holes through quartz beads; this fact was conclusively proved to me by the splendid series of amethyst and cornelian beads arranged chronologically in the Ashmolean Museum. The larger stones were bored with this tubular drill whilst the solid or burr drill was used for smaller stones.

There are also examples of scarabs in the same museum cleverly engraved with arrangements of circles cut with the tube drill.

This tubular drill has been universally employed in the working of stone, and proves an efficient and valuable ally to overcome the most obdurate tasks. To illustrate this I might mention that, worked with the bow, it is the principal instrument used by the Chinese for their wonderful carving of jade; that it was known and used by the Aztecs for their mysterious and equally remarkable quartz carving, the remains amply testify; and, as is well known, the greatest glyptic monument—the St. Gothard tunnel, drilled through quartz—would have been impossible without its aid.

I might mention in this place that the Maories of New Zealand use a similar drill, but it consists

FIG. 5.—RED CORNELIAN.
(Three-sided bead seal. Crete. 1600 B.C.
In Sir Arthur J. Evans's collection.)

of a piece of quartz mounted on a shaft of wood and operated by the up-and-down movement of a transverse stick with a thong. The consequence is that their holes are very clumsy and irregular. Sand applied by the friction of a piece of wood is their principal agent in carving the material, not forgetting the valuable quality of patience: it often takes thirty years to produce one piece of work.

To proceed, we must consider the work of the early Greeks and the Etruscans, who, with their spirited drawing and clever handling of the technique brought the art to a higher level.

The illustration of a sard in the British Museum of Græco-Italian workmanship of the fifth century B.C., shows what is obviously an engraver using the bow-drill (Fig. 6). The engraving of this gem proves that the burr drill was still used with the aid of the bow as represented; but we see clearly, especially in the work of the following centuries, evidences of the use of a

FIG. 6.—GEM ENGRAVER USING THE BOW DRILL.
(Sard in the British Museum. Græco-Italian
work. Fifth century B.C.)

fine disc tool in the modelling of the figures. This freer use of the disc tool would necessitate some improved method of technique, and it is

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quite possible that the first use of some form of lathe for engraving gems can be attributed to this period. This sard in the British Museum helps this theory; the raised position of the leg, apparently resting on a pivoted treadle connected with the projecting arm at the back, might give a thrusting movement to the bow if attached to the top of the arm, the bow working on the horizontal shaft of a drill, thus leaving both hands free for the engraving—a very essential point.

In the Greek engravings from the sixth century onwards, we see the finest examples of intaglio engraving possible, generally in low relief, on the different varieties of quartz. With their beautiful mythology to supply the motive and their wonderful power of sculpture, it is not surprising to find in their engraved gems a quality of beauty quite consistent with their statuary and coins; indeed, from the similarity of the engraving of the intaglio on stone and metal, we can presume that one artist would be responsible for both, as has, indeed, been the case ever since.

The most important feature in this period, one that worked a revolution in the art of engraved gems, was the discovery, presumably in the fifth century, of the value of the onyx, from which to engrave cameos. The onyx is a species of agate having parallel layers of stone of different colours, enabling the artist to carve a design in relief in the upper layers, thus obtaining a strong contrast to the darker coloured layer beneath. Great possibilities were now open to the clever Greek artists to engrave reliefs in this remarkable product of Nature, and that full advantage was taken of the opportunity numbers of magnificent cameos remain to testify. Carvings in relief in precious stone are met with earlier than this period in Egypt throughout the Dynastic period, in the form of the scarabs I mentioned earlier in my paper, and this form was also used by the Phœnicians, Etruscans and Greeks, and undoubtedly suggested the idea to the later artists of carving reliefs in precious stone for purely decorative purposes.

Cameos in onyx are not of frequent occurrence till the first century B.C., when the Greek artists, who flocked to Rome, produced large numbers for the luxurious Romans. These Græco-Roman cameos often attained extraordinary size, considering the nature of the material. Vases and cups of onyx, agate, crystal, etc., were now produced in great profusion, many of them being beautifully carved, like the agate vase in the Waddesdon Bequest in the British Museum.

The most magnificent cameo in point of size is the Triumph of Germanicus, carved in an onyx of five layers, measuring 13 ins. by 11 ins.; it is easily the largest in the world, and, after a chequered history, is now in Paris. It demonstrates with what a cunning hand the artist has used the various layers of a very beautiful stone. Smaller but finer cameos are seen in the onyx carved with a similar subject in Vienna; in the dignified head of Augustus in the British Museum, engraved in a stone of very pure colour, and in the very beautifully carved head of Medusa in Sir Arthur Evans's collection.

These beautiful specimens of the glyptic art convince us that the appliances used by the Græco-Roman artists had great cutting power, and it is apparent that revolving discs and burrs were principally responsible for the engraving.

FIG. 7.—THE ANNUNCIATION OF THE VIRGIN.

(Three-strata onyx cameo from the French collection. Tenth century. Byzantine.)

Although no actual representation exists of an engraver of the first century, it is generally agreed that the lathe was used to revolve the tools; certainly the nature of their work would necessitate some such apparatus. This implies that the tools used to-day by gem engravers are very similar to the simple instruments of the engravers of the Græco-Roman school—*i.e.*, a shaft or spindle, having a disc at the end would be placed horizontally on two bearings and revolved by means of a wheel below, the edge of the disc cutting with the aid of diamond or emery powder, when the stone is placed against it.

This, then, is the simple instrument that produced the masterpieces from the time of Alexander in the fourth century B.C., and which has been used in various forms ever since. It is important to add, however, that the diamond

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point was the important agent with which the Greek artist finished his work.

In some engravings, particularly the earlier Greek intaglios, the whole of the detail, such as drapery, hair, etc., appears to be incised by this means, and it is distinguished by a freedom of drawing almost approaching sketchiness, that cannot be expressed by any other tools. In the first century A.D., the point seems to have been entirely superseded, if we can judge by one authentic specimen—an intaglio engraved with the head of Pallas Athene by Eutyches, one of the clever sons of Dioskorides. From a long and careful examination of this piece, I have come to the conclusion that the disc and burr tools were entirely responsible for the engraving; a use of the point is seen, however, in some Græco-Roman gems.

The Romans did not distinguish themselves as gem engravers, all the fine engravings of this period having been executed by Greek artists who, in company with the masters of other branches of art and literature, flocked to the hub of the Roman Empire. Thus, with the decline of art that set in about 300 A.D., we find the beautiful cameos and intaglios of earlier days replaced by work of a mediocre kind. The departed glories of Dioskorides, Felix, and Evodus are but faintly reflected in the poor Roman craftsmen who coarsely cut motto cameos and other insignificant work. Soon we lose the art altogether in the West, but see it continued in Byzantium, and further east in Persia.

From the fourth century onwards the strong influence of Christianity is seen in the Byzantine cameos and intaglios; engravers would often alter or add to an antique gem, having a representation from the Greek mythology, thus making it represent a scene from the life of Christ.

In Persia, under the influence of the Sassanian kings, fine stones were coarsely engraved with the portraits of the various monarchs, hunting scenes, animals, lettering, and monograms. These Sassanian gems add one point of value to a technical consideration of the art—*i.e.*, you are able to see clearly the style of crude disc tool work, of which they are mainly composed, and compare it with the early engraving of the diamond point, thus distinctly noticing the points of difference.

Poor workmanship and tasteless drawing are the characteristics of Byzantine gems, the only redeeming feature being a certain decorative filling of the space.

From the sixth century to the dawn of the fifteenth is a blank in the history of the glyptic art, with only a short revival about the tenth century, when cameos and intaglios with religious scenes were roughly engraved—as witness the three-strata cameo of the Annunciation in the French collection (Fig. 7), and in the British Museum the large intaglio of the Crucifixion in crystal, once belonging to Lotharius.

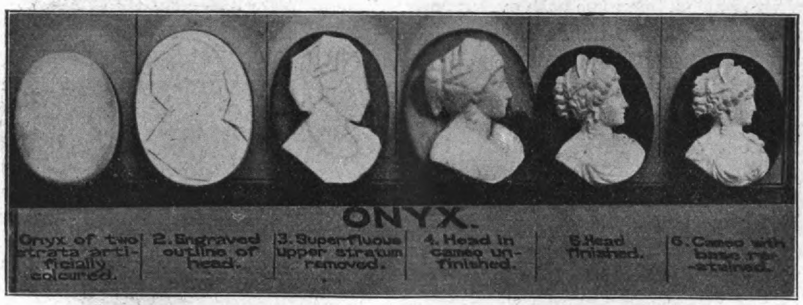

FIG. 8.—THE EVOLUTION OF THE CAMEO.

In the fourteenth century the art was reintroduced into Italy, and before the fifteenth century was far advanced was revived artistically and technically to an amazing degree. Though the designs engraved on gems during the revival followed closely the antique style, yet they fail to achieve the grand and dignified manner of the Greek engravings, or to approach them in the matter of large and magnificent pieces. It is true some artists of this period copied the antique so closely that it is not easy to distinguish the difference. It is consequently difficult to give rules to differentiate between antique and Renaissance gems. Undoubtedly the greatest asset is a knowledge of the styles of art of the different periods, as it enables you to detect the imprint and evidence that every gem must bear of the hand that engraved it. A knowledge of the technique is essential, so as far

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as possible I will endeavour to show a few points of difference between ancient and modern engravings.

In modern cameo work a large thin disc, known as a slitter, is employed to remove the bulk of the stone by first cutting vertically and then horizontally; by continuing this process all round, only the mass of the stone required for the design is left (Fig. 8). This results in the large border of background characteristic of modern cameo engraving. There is no evidence of the use of such a tool for cameo engraving in Græco-Roman times, so we find their designs fill the whole space of the stone, a necessity enforced by the laborious method of grinding the stone away with burr tools.

An important difference between the backgrounds of antique and modern cameos is also noticeable, in that the former have an undulating surface, whereas the modern, owing to the advanced technical methods, are perfectly level. This is seen to perfection in the bust of Juno in the Paris Museum (Fig. 9).

It is generally supposed that high polish in the engraving of a cameo or intaglio is a sign of antiquity; this, however, is not so, as the modern artists can polish their work equally well. There is, however, a point of difference; the ancient artists largely used corundum, or emery, which during the process of engraving wears fine and so produces a cut with a dull polish. The modern engraver using diamond dust with an iron tool has to revert to the ancient practice in order to polish the engraving, with the result that unless it is done with great care, the minute cuts will be left rough. This is consequently a characteristic of many forgeries, that some parts are quite rough, whereas other parts have a very shiny polish. Other characteristics of modern work are the protuberance of the relief and the undercutting of some parts of the design, while antique work is generally flat and simple in relief, the edges being cut down vertically. Cameos of Roman origin, however, are bold in relief.

It has been said that it is impossible to identify a clever imitation of an antique, and this is to some extent true, so skilfully have the forgers copied the antique method and produced the ravages of time with cunning artifices. We must, therefore, rely on a knowledge of the styles of art and the subtle differences of technique.

FIG 9.—BUST OF JUNO.
(Three-strata onyx cameo. Good sixteenth century work in the French collection.)

FIG. 10.—QUEEN ELIZABETH.
(Cameo in three-strata onyx. Sixteenth century. French work.)

Cameos were produced during the Cinque-Cento period in the greatest profusion, often crowded with detail amazingly minute. This is also a characteristic of their intaglios, as is well illustrated by the signet of Michael Angelo that has seventeen figures in the space of half-an-inch. Ornamental intaglios in large plaques of crystal were also a feature of the age. It is during the sixteenth century that we first meet with the art in this country, one Richard Astyl being noted as "King Henry the Eighth's graver of gems." He may have been responsible for the very beautiful cameo portrait of King Henry VIII. and his son Edward VI. in H.M. collection at Windsor. These Tudor cameos form a series unique in the decorative treatment of the various colours of the different strata of the stones, as is well seen in the beautiful cameo of Queen Elizabeth (Fig. 10), possibly engraved

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by Jean de Fontenay, who was invited over from France to engrave cameo portraits of the Virgin Queen, that she might present them to her many admirers. Judging from the number of these cameo portraits, she had a numerous following.

They are many of various sizes, apparently from the same hand that engraved the example illustrated.

After the beautiful productions of the Cinque-Cento, a decline is noticeable, the engravings of the seventeenth century becoming coarse and uninteresting, and it was not till the eighteenth century that a marked improvement set in, fostering particularly the production of intaglios.

FIG. 11.—GROUP IN RED JASPER, IN THE LUXEMBOURG MUSEUM, PARIS. (By M. Tonnellier.)

During this century a great wave of glyptic enthusiasm spread over the country, and every individual who desired to be considered a person of taste in the arts found it necessary to have a knowledge of our subject, and to possess antique examples of the art, with the result that enormous numbers of antiques were manufactured to meet the demand. Fortunately the bulk of the work bears the stamp of the eighteenth century, and is easily recognised.

It is necessary to observe that a large proportion of the gems are cleverly engraved, the rewards being so excessive that even the best artists were not above engraving forgeries of antique gems, polished very highly and with the very necessary addition of a name in Greek characters. The most impudent series of forgeries were the gems, about 3,000 in number, engraved on very fine stones, to the order of Prince Poniatowsky; they all bear the name of a supposed ancient engraver, and are quite well engraved, but from the pictorial nature of the designs, which generally include a free use of rocks, clouds, flying drapery, etc., coupled with an airy and superficial prettiness of treatment, there can be little difficulty in picking them out, though I have known them to be purchased for antique or Renaissance work. The same remarks apply to the other forgery illustrated.

With regard to the atrocious engraving, presumably a boar or pig, illustrated in the same series, I cannot express myself too strongly. This bad modern engraving, that impudently pretended to be antique, has nothing to recommend it, yet these wretched engraved stones, the work of ill-paid German workmen who produce them by the gross, are constantly bought and valued by persons who would not deign to look at an equally bad forgery of a picture or sculpture, and prove that a more extended knowledge of the glyptic art is necessary.

Nathaniel Marchant and Edward Burch, both Royal Academicians, are the prominent English gem engravers of the eighteenth century, and I am glad to acquit them of the charge of forging antiques. They worked in the classic style, as did their contemporaries, and both were engravers of intaglios for use as seals and ornamental purposes. Marchant was easily the foremost, many of his figure subjects being admirable and delicate examples of intaglio engraving. Notable among the numerous foreign competitors of these artists were the three Pichlers, father and two sons, engravers of cameos and intaglios, and Girometti, who also cleverly engraved dies for coins and medals.

Lawrence Natter, a German and a clever engraver, was a great offender with his forgeries

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of antique gems, and, having some reputation in his day, said that ancient engravers used a certain parallel tool for engraving the hair, etc. This theory is not supported by the evidence of the antique gems, and Natter may have said this solely that he might more easily copy the parallel strokes of diamond point engraving by using this favourite modern tool. In the British Museum a finely engraved head, presumed to be that of Demetrius Poliorcetes, shows the use of this tool to great advantage, and in all probability was engraved by this very artist.

There is so much of interest in this period of which nothing is generally known, that I am loth to leave it, but after a few remarks respecting the Roman gem engraver Pistrucci, I will progress to my final stage, the consideration of the work of to-day. Early employed in Italy in fabricating antiques, Pistrucci came to London in 1805, rapidly became famous for his cameos and intaglios, and was appointed the chief engraver to the Mint. Whilst there he designed and engraved the elegant St. George and the Dragon that we use on some of our coins to-day, an engraving that clearly shows the superiority of directly engraved dies over the modern method of mechanically producing the die from sculptors' larger models. The point is interesting in view of the fact that for the first time in the history of our country our coins and great seal have been produced not by engravers but mechanically from large models by eminent sculptors, who cannot understand the requirements of minute work, or the technical difficulties to be overcome in order to produce a good coin in striking.

During the nineteenth century a great decline in the glyptic art set in. This was not the fault of the artist, but was due to various causes, chiefly the introduction of imitation cameos in shell, a valueless and easily-worked material, to the adoption of up-to-date methods of sealing with adhesive gum instead of wax, which made the elegant intaglio a luxury rather than a necessity, the use of steel dies to replace the seal, and the march of the fickle goddess of Fashion; in consequence of which artists of the Victorian Era turned their attention to heraldic engravings that show excellent technical ability but are lacking in design. It is therefore supposed that the art is dead, but this is wrong. True we have few in this country besides the clever heraldic engravers, but in France, owing to the influence of a school for the teaching of gem sculpture, carvings in precious stone have been produced within recent years that for ambitious conception vie with the large carving of the antique. Many of these sculptures are of extraordinary dimensions, considering the valuable nature of the material, and are unique monuments to the patience and skill of their authors.

The group of the Centaur with Deianira (Fig. 11), by Tonnellier, is of red jasper, and is in the Luxembourg Museum in Paris; it is very cleverly carved, as is also the figure of Victory by Lemaire, composed of various stones, jasper forming the cloak, white quartz the head and hands, the clouds of crystal, whilst other details are expressed in various stones of suitable colours, all pieced together with extraordinary skill. With the exception of Mr. A. Lyndhurst Pocock, no English artist has attempted work on such a large scale. The artistic carvings of this artist are equally interesting, and show in the clever manipulation of the colours of the stone a technical skill equal to that found in modern French gem sculpture.

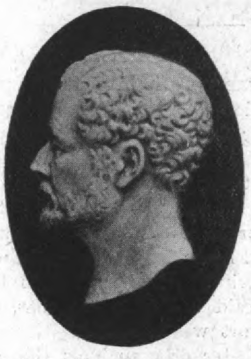

FIG. 12.—PORTRAIT.
(Cameo in onyx by Cecil Thomas, 1911.)

In order to enable my contemporaries to indulge in similar arduous undertakings, I might mention that the same principle is employed for this larger work that is used to engrave cameos and intaglios—*i.e.*, discs and tube drills charged with diamond dust are revolved in a lathe, the difference being that the size and strength of the tools must be sufficient to take the strain of cutting the heavy lumps of stone. The slitter and the tubular drill are the most valuable tools, the slitter removing piece after piece of superfluous stone, and the tubular drill cutting through the interstices of the group. When the bulk of the stone has been removed by these means, a large burr tool will model the forms, and by slow and painstaking effort bring the desired result. If the work is made up of various stones, then they must be fitted together by dovetailing, inlaying and insertion. The polishing is then obtained with copper wheels and emery, and

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afterwards the various polishing powders. As an example of the labour involved in the more ambitious pieces, I might mention that in one case four valuable pieces of stone were carved before a suitable piece was obtained, one piece being discarded after three months' work had been expended. One year is often insufficient to produce a fine statuette in precious stone.

I have now dealt with a few phases of a beautiful art that is becoming too obscure; an art that in this country requires a fostering hand. We cannot expect our Government to aid the art as is done in France, so we must rely on private patronage and the valuable schools of art, on Societies such as this, and the Goldsmiths' Art Council, to teach and encourage a better understanding of gem engraving in this country. As an enthusiastic follower of the glyptic art it is my earnest desire to help forward this movement, and if I have contributed to this result and created greater interest, I am more than gratified.

DISCUSSION.

THE CHAIRMAN (Sir Arthur Evans), in opening the discussion, said it had been a great privilege to him to hear the author's interesting paper, because it came from one who was not merely speaking of the subject theoretically, but had practised it, who knew all the tools, and had studied all the technical processes of the different ages. Personally, he had had a long affection for the study of gem engraving, and he thought the best that could be said about it was that, so far as the history of art was concerned—though there were perhaps greater arts, such as the arts of sculpture and painting—the art of gem engraving was about the only art which could be followed continuously for a period of something like 5,000 years. Like other arts it passed through dark ages. Its beginnings were traced in Babylonia and Egypt; it then sprang up on an independent basis in Crete, which was far enough removed from the East and from Egypt to be capable of what Syria could not produce—an independent art. The wonderful work of early Minoan Crete, which he had done something to investigate, was extraordinary in its way, because in no country, not even in Japan, was naturalism carried to such a height as in some of the old Cretan works. But in Crete, as elsewhere, the period of the dark ages ensued when the decadence of the art was manifest. One found what were then the barbarous Greeks coming in and substituting rude linear copies. The people who had learned to work in hard material sank into working in soft material, which, as the author had pointed out, was one of the great differences. When a beginning was made, the people were quite incapable of working in hard materials, such as any form of crystal; they began in soft stone, like steatite, or a soft material such as ivory. That beginning was the ending. The work of Crete sank again into soft materials; the Greeks began on barbarous lines; then they gradually learned to work with harder material, and that very brilliant chapter in the history which the author had sketched began. They improved that by learning to work in cameos, though very little of the older Greek work was done in that line. Until the time of Alexander cameos were really practically unknown, and even then until the borders of the Roman period they were extraordinarily rare. But the work of gem engraving went on through Greek times; it was still kept up in great technical perfection in the earlier part of the Roman Empire, and then it sank again. He was not inclined to take such a low view of some of the Byzantine work as the author had done. It was barbarous in a way; it suffered in the same way as most other Byzantine work, but it was sometimes very careful and minute. But there again the art was practised on soft materials, most of the later Byzantine works being of steatite, and the same was largely the case in other parts of Europe. There were, for instance, Saxon seals not badly worked on ivory. Then, again, a revival took place in the West, a great part of which, he thought, had never been properly studied. Traces of it could be seen in the impressions of seals used on documents, but in the earlier English seals of the twelfth and thirteenth century there was some extraordinarily good work. It might be partly on metal work, but it was very hard to separate the two. Looking over some impressions of twelfth and thirteenth century English seals, he was greatly struck by the fact that probably, in this country and in France, the art at that time attained a higher degree of excellence than it did in Italy, and that was found in some other branches of art. By the fourteenth and fifteenth century, the time of the Cinque-Cento, the Italians went ahead. One point to which the author might have referred was the intimate relation between gem engraving and the engraving of the dies of coins, the engraving of metal matrices, and also of rings in precious metals. So far as he could see, in the earlier periods there was no real distinction to be made as far as the design went; there was a great deal of resemblance in technique. The great Sicilian engravers, for instance, who produced the most beautiful coins in the world, were also engravers of gems. What Pistrucci did for St. George and the Dragon, or for the beautiful Waterloo medal, which he copied from a coin of Magna Graecia, was done by the great Sicilian engravers of the fifth century before the English era. There was a close inter-relation between the two, and they could not be separated. It was because no real school of gem engraving existed that the engraving of the British coinage had sunk to its present level, and that the methods of procedure for producing medals were opposed to everything that was regarded as fine art in that material in any age but the present. He thought that process of reduction to which the author had

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alluded, which transferred the methods of one art to another, was wholly wrong, and wholly vicious. Personally, he was in the unfortunate position of being a collector, having collected gems in Greek lands and elsewhere for a great number of years. It was exceedingly difficult to tell what was genuine and what was not, and he did not know that after studying for many years he would have been able to recognise the ancient work from some of the eighteenth century copies, if he had not acquired a certain instinct from observing what actually came out of the ground. When once the eye was trained to that, some kind of criterion could be formed. The author had asked at the close of his paper, what the future of gem engraving was to be in this country. One was almost inclined to despair. It was partly the fact that at the present day seals were no longer necessary, gum being used instead. In the days of Egypt, Babylonia, and ancient Crete, the seal stood in the place of a key, one's possessions being secured by sealing them up. Even when locks and keys came in, as they did in classical times, gem engraving was at a certain disadvantage. Now, however, that envelopes were simply licked there seemed to be a very little future for intaglios; and, owing to the fashion of heraldic designs, even when seals were used they were generally not of any real artistic merit, and were made of metal. He thought, however, that possibly there might be some future for cameo engraving. The cameo had perhaps some future as a decoration, and ladies' fashions might bring the cameo again into vogue. All those present probably had a vague memory of the chaste shell cameos of the early Victorian period; they were not very beautiful, and the decadence from hard beautiful agate to shell was a great disadvantage, but nevertheless it was the reflection of an old and excellent tradition. It seemed to him that for brooches and for other purposes it was possible to revive the cameo, and he was sure everybody wished the author and his fellow-workers the greatest success in reviving that ancient and beautiful art.

Professor Ernest A. Gardner said his knowledge of the subject, which was very limited, was confined entirely to the historical and artistic side, and he had therefore learned a great deal from hearing an exposition on the subject from somebody who had a practical knowledge, who knew what the tools were, and how they were used. There was one point which had been hardly referred to as one of the causes of the decadence of gem engraving, and of the somewhat despondent view taken of it both by the Chairman and the author, to which he wished to refer. When it was found that the material in which anything was carried out was thought more of than the artistic skill that was used in producing it, then art was in a very bad way, and he believed that was what was the matter with the people of this country at the present moment. That was evident from the horrible misuse of the word gem which was still prevalent. The author actually had to begin his paper by defining what a gem was. The man in the street believed that when a gem was referred to it meant a precious stone, a diamond, or a ruby, or whatever it might be. As a matter of fact, a gem was essentially a work of art, a thing which received its value from the exquisite work that was put into it. Of course the material must be worthy of the work, and many of the precious stones were the most beautiful and suitable for that artistic workmanship, but it was the artistic workmanship which was the essential thing. It was because the people of this country had so largely lost sight of that fact that the art of the gem engraver had fallen on such evil days.

Dr. T. G. Pinches thought there was one point in connection with gem engraving in general which should not be forgotten, namely, the importance of the material. If the Babylonians had not used hard stone for their wonderful engravings they would not be in existence now, so that the durability of the stone was an essential element. In considering the difficulties connected with the subject, there were some points which required elucidation. An important question, for instance, was that of the use of the lathe. Personally, he began life as a die-sinker; he did not know anything about stone seal engraving; and he found, when he attempted to engrave on a curved surface, that his graver slipped off at a tangent. He had to follow the curve of the surface with his hand, a difficult thing to do. It struck him that the tubular drills, to which the author had referred, would have to be held very steadily indeed in order that they should not slip off the surface being engraved at the first attempt to turn them. That point, it seemed to him, made it practically certain that some kind of lathe must have been in use even in very early times. A great deal might be said about the cylinder seals which were met with in such large numbers among Babylonian antiquities, and also about the history of the art in that country—a history which reflected the political changes that took place. The peculiarities of the methods were well worthy of notice, particiliarly their sketchiness. He imagined that the skirts of the figures which were represented on the cylinders were produced by simply grinding away a portion of the stone on a flat surface, which might even have been a kind of grindstone. Whether that was the case or not he did not know. One peculiarity of the history of the art was that a long time ensued before the artists hit upon the importance of a decided outline to the body and the robes of their figures. Another point which must have contributed enormously to the perfection of the art was that if a beautifully engraved gem was held up to the light it was possible to see the contour of the figure, the outline of the cheeks on a head, it thus being possible to test the progress of the work without having an impression made. The present low position of the art was one much to be regretted, and more attention should be paid to it in this country and elsewhere. One of the things the Government might do to benefit it would be to take off the tax

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on heraldic devices when applied to seals. It was a very hard thing that a man could not have any device he liked engraved on a piece of stone, because for some reason or other the Government thought it proper to put a tax on it.

MR. A. LYNDHURST POCOCK thought the definition of the word "gem" given by the author was correct, namely, that the art, the beautiful design, constituted the gem in whatever material it was made. The art undoubtedly had first place; but how was a line to be drawn between works executed in soft materials, such as serpentine, lapis, etc., and harder stones from, for instance, labradorite to the diamond? He thought a strong line should be drawn between those stones which can be scratched with steel and those that could not. A lapidary working in stone soft enough to be cut by steel was not, in the fullest sense, doing true lapidary's work; his special tools were not necessary. They might have gems in shell, wax, paint, or any other material, but they were not lapidary's art unless the material they were cut in was harder than could be cut with steel tools. To make that point more clear, he wished to say that a lapidary might call himself a sculptor, but a sculptor could not call himself a lapidary. That art, owing to the great expense and labour in production, could never be produced in quantity, unless the artistic patronage was considerably increased. Mechanical production by sweated labour, or by persons who had no real love for it, was a degradation alike of the art and the producers of it. The supply could not exceed the demand without very much lowering the standard, which it should be their aim to raise to its highest.

MR. CECIL THOMAS, in reply, said he was particularly grateful to the Chairman for the kind words he had spoken, and for the appreciation the audience had shown of his paper. The point that had occasioned the greatest comment was the question of the engraving of dies and stones. As the Chairman had mentioned, the engravers of stone in Greece, and later in Rome, were also the engravers of matrices for dies, and it was by reason of that fact that they were able to produce such beautiful work so splendidly illustrated by their coins. Since then engravers had worked in both materials. It was not difficult for the engravers of stone to work in metal, but owing to the present commercial age they had become split up, and the engraver of one material confined himself exclusively to it. He noticed that the Chairman did not agree with his opinion regarding Byzantine art. The art of gem engraving was classical, and the nature of the material demanded fine technique in order to bring out the fine qualities of the stone. It was not suitable for rough and careless work such as was found in Byzantium, although the decorative qualities of Byzantine work gave it a charm that was perhaps not found in work of a more classical period. He quite agreed with the Chairman's statement that the English seals of the thirteenth and fourteenth century were most beautiful productions of art, and he wished present-day engravers would follow in those traditional footsteps and produce work that came within the same pale. It had always been a great regret to him that gems of that period had not been found, because he felt that early English gems were probably as beautiful as early English seals. It was impossible to look into the future and predict what the future of gem engraving would be. He tried to see something rosy, but there had not been much rosiness since the days of the shell cameo, which was mostly responsible for the ruin of the art. After a little practice, it was possible to produce a beautiful cameo in shell with a steel tool, provided one had a certain amount of artistic ability, but it took at least six years before it was possible to attain to anything like the technical skill necessary to produce the minute work that was required in seals containing heraldic devices. The school in Paris was a most exclusive one, into which it was difficult for an Englishman to get, and gem sculpture was there taught in the finest possible way. There was nothing commercial about it, it being purely for the sake of the art that gem sculpture was taught, and the French Government actually provided an annual grant to the principal engraver, in order that he might keep the art alive. A good many comments had been made with regard to the word "gem." Personally, he had used the word in its correct and original sense, meaning that it was anything choice, although he feared that it was difficult to say where the line of demarcation should be drawn, separating what were suitable gem stones from what were not. As an engraver, he thought it a pity that some such line as Mr. Pocock had suggested could not be drawn. Mr. Cyril Davenport, who was unable to be present at the meeting, had written to him, saying that among other important points raised in the paper he was particularly interested in the treadle that was used with a bow drill. Such an attachment, Mr. Davenport thought, would have been difficult in early times, but was it at all possible that one man worked the bow rythmically, while another manipulated the stone against the cutting edge? Personally he thought it was very difficult to say exactly what the ancient engravers' tools were and how they used them, but he agreed with Mr. Davenport that one man might have worked the drill and another controlled the stone. That would give that control over the tools which was absolutely necessary in order to obtain the results produced. He quite agreed with Dr. Pinches' suggestion that in engraving the rounded surface of a cylinder the tool would slip. Some way of starting must be obtained. This would make necessary some advanced method of revolving the tools as had been suggested. The early work on stone, however, showed that the corundum point was largely responsible for the finish of the engraving; by experiment he had proved that

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with labour and patience it was possible to obtain any result with this simple instrument. In conclusion, he would like to express his thanks to Mr. S. Henson, Mr. G. Donne, Mr. S. Pegg, Mr. A. G. Ready, and Mr. F. Hyams for lending the interesting examples exhibited.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Mr. Thomas for his interesting paper, and the meeting terminated.

SOUTHERN PERSIA AND ITS DEVELOPMENT.

The critical state of affairs in Southern Persia, and the ominous rumours of the approaching partition of the country, are the outcome of a series of events which have been shaping for the worse for some years, and which have now reluctantly compelled the British Government to take serious measures for the protection of British Indian traders domiciled in the country. The last Consular Report for Bushire for 1910-11 sheds considerable light on the occurrences which, during the past year and a half, have gradually brought the break up of the Shah's dominions within the range of proximate politics. Bushire with its hinterland is part of the Persian Province of the Gulf Ports, Bushire itself being the headquarters. The Persian Government only assumed effective control of Bushire sixty years ago, till when the town had more of an Arab character. Even now, to a large extent, the population of the town and its surroundings is more Arab in blood than Persian. The inhabitants follow the occupations of cultivators, traders, fishermen, labourers, and coolies. In the last-named capacity their services are in large demand for work in Basra and on the Tigris, on account of their stamina and energy being superior to that of local Arabs. The garrison of the town and district of Bushire consists of about 200 soldiers and 20 gunners. There is little connection and intercourse between Bushire and Northern Persia. The immediate hinterland is tribal in character, each district being ruled by a local chief or Khan, and comprising twenty to thirty or more villages. The tribesmen, mostly well-armed, and owing feudal service to their chiefs, have the land under cultivation of wheat and barley. The aggregate population south of the mountain range is estimated at upwards of 83,000. Extensive smuggling of rifles and ammunition into the country has permitted the chiefs to arm their men well, and this smuggling industry—one of the evil results of the present Custom tariff—has considerably enriched the districts. But neither the net proceeds of the Bushire Customs, which are assigned to the service of the Imperial Bank of Persia Loan for £1,250,000, nor the net revenue from all sources which is despatched to the capital, is expended on the needs of the province, so that the dilapidated condition of the town is now becoming more and more conspicuous. In 1907-8 trade in Bushire was flourishing, but since then, owing to the focus of Persian anarchy having shifted to the southern provinces, the hinterland and the whole province of Fars have shown a steady decline. The year 1910-11 shows an almost unvarying record of robberies and raids along the caravan route, and the amount of claims put forward by British commercial houses and traders, and entered against the Persian Government for looted goods or denials of justice, now totals about £4,950 as regards claims filed at Bushire, and about £9,000 as regards claims filed at Shiraz.

In Fars, during the year under review, the bazaars were congested; pedlars, village dealers, and petty merchants could not circulate freely, and Lar, Fasa, Kazerun and Behbehan were the scenes of considerable fighting and plundering. Along the two main trade routes to Isfahan, which is one of the most important commercial centres of Persia, unfavourable conditions have also prevailed, and cotton imports from Manchester in particular have markedly declined. And, be it noted, while Russian piece goods into all Persia show an increased import during 1909-10 of 1,318 tons, there was a decrease of British goods to the extent of 1,874 tons.

No steps have been taken by the Persian authorities to put down the levy of blackmail which is such a heavy charge on trade with Shiraz. This is the more flagrant because the abolition of all exactions in the interior was one of the most important conditions of the Commercial Convention of 1903. These exactions amount in the aggregate to from £1 7*s.* 5*d.* to £1 14*s.* 7*d.* for every ton of goods carried along the 180 miles of route between the two towns.

The Consular Report for Bushire for 1910-11 says there are still no signs of the economic development of the southern provinces of Persia, and the improvement of methods of transport by the construction of railways has become a real necessity.

In connection with this, it is important and interesting to note the progress that is being made with the Trans-Persian line, which is strongly supported by Russian banks, and which various English financial houses are also interested in. This line contemplates the running of a through line from Europe to India by way of Vladikafkar, Tabriz, Teheran, and Seistan. The Government of India, whose co-operation is, of course, necessary, have already deputed Mr. Johns, the Chief Engineer of the Oudh and Rohilkhund Railway, to carry out the necessary surveys for the best alignment on the Indian side—that is to say, in Baluchistan and Southern Persia. The Government of India have, however, shown discrimination in stipulating that the surveys shall not be confined to the route favoured by the promoters of the Russo-Persian line, but shall include various feeders and branches, one running to Mohammerah, at the head of the Persian Gulf, which would thus admit of being prolonged, by way of Basra and El Jauf, through Northern Arabia and Sinai, to the Suez Canal. Such a line would prove of great importance, as it would unite Egypt and India, and fulfil generally the conditions of an All-British railway, which a trunk line passing through Germany, Russia, and

the Russianised sphere in Northern Persia could never pretend to possess. For instance, most "Railway to India" projects claim at the outset the privilege of conveying the mails to and from the East, but it is hardly conceivable that England would ever permit the mails to her great Eastern Dependencies and Colonies to be entrusted for safe conduct to Germany and Russia. In time of peace this might be well enough, but in case of war the necessity of a mail route within reach of British control would clearly be paramount.

The greatest interest, therefore, attaches to the coming development of Persia, for which pending events are now paving the way.

THE WEAVING INDUSTRY OF EGYPT.

A merchant, who travels continually between England and Egypt, assured the writer a year ago that there was no weaving industry in Egypt. To use a homely phrase, he "spoke without his book." A considerable part of the peasant population earn their living in this way. There is no export, as most of the stuff made is used in the neighbourhood, or, at all events, in the country. There are technical schools at Tonkh, Fayoum, and Mansourah, and within the last three years there has been a special inspection, by order of the Government, to study the desirability of furnishing professional instruction. The difficulty in the inspection has been that the fellaheen treated the efforts to help them with unfriendliness and distrust, and were not inclined to furnish reliable data.

In the province of Kalioubyeh there are eighty-seven villages, each containing from six to thirty looms, except the village of Kalioub, which contains several hundreds. There is rarely more than one in the same house, and this is generally set up in a dark, dirty little room. Occasionally, however, something rather more important is to be seen, and more like a regular workshop. At Kalioub, for instance, there are small manufactories, with as many as thirty looms. Linen, cotton, and wool are used. Silk does not appear to be used in this province. The raw materials are generally grown in the neighbourhood, but at Kalioub they have to be bought from Cairo.

The cotton, wool, and linen are all spun by hand by old men and women, and the thread is usually put direct on to the bobbins rather than loomed into skeins. At Kalioub a great stock of cotton and linen, ready for sale, is to be seen; sheets, table napkins, towels, bed covers, handkerchiefs, stuff not made up, etc. This is all used in neighbouring villages. There is a roughly-made stuff, rather like sacking, which is used for men's shirts. It is bought in the natural colour at the weaver's, and made up by the women. In the smaller villages this is almost the only use to which linen is put. Wool is woven for the "galibiehs" and "deffiyehs," as the outer garments are called, and dyed black or brown. It is also used in the manufacture of carpets.

Some of the prayer-carpets show considerable imagination. The simplicity of the needs of the inhabitants in distant localities makes it quite unnecessary to have any stock of garments kept on hand for sale. The men wear two garments, and the women one. If a new one is wanted the weaver is directed to make it. In fact, the weavers do not always have work enough to keep them occupied all the year round, and spend a part of the time in the fields.

The looms are mostly of native manufacture. The most important parts, such as the combs, are bought in Cairo. In the small villages the looms are of the simplest description. At Kalioub they are slightly more complicated, and are sometimes worked with four or six pedals. The stuffs woven are one metre, ninety centimetres wide. The loom is generally worked by a man and his son.

From the province of Fayoum some 20,000 woollen "deffiyehs" are sent annually to Tanta, Alexandria, and Syria. In the smaller villages of Fayoum enough flax, cotton, and wool is produced to furnish the local weaving trade, but at Medinet-el-Fayoum cotton from India and America is used, and at Fodam big quantities of wool are bought from Cairo. A large quantity of rather coarse material, in black and white, is used for women's garments, and called "omache harim." It is rather like crochet in appearance. From Fodamin considerable quantities of cotton material are sold by the piece of fourteen metres at 2*s.* 5*d.* This represents two days' work. Where workmen are employed the average salary is 1*s.* 2½*d.* a day.

There are forty weaving manufactories at Damietta, in the province of Dakahliyeh. Some of these contain twenty looms, but most only two or three. One manufacturer turns out 170,000 metres of silk a year. This represents about a third of the whole local industry. There are about 1,500 persons engaged in weaving in the city. At Manzala a lot of raw silk is spun, all of which is sent to Mahalla-el-Kobra to be woven. About four or five hundred men and children, and between five and six hundred women are employed at Manzala. There were formerly many looms at Manzala, but the trade has been transferred to Mahalla-el-Kobra.

There are about three hundred cotton and linen weaving looms in Dakaliyeh, and about twelve hundred persons working at them. The village of Mit Khamis, which formerly possessed two hundred looms, has only thirty-six to-day. Farascour has the greatest number of wool looms in the province, viz., fifty.

The raw silk used for weaving at Damietta comes mostly from China. None of the flax used in the province is produced locally. The linen woven is used for men's shirts, and sent to big towns without the province; handkerchiefs and cloths are also worn. There is not so much cotton woven in the province as linen. The produce of the wool looms at Kom-el-Nour is sent to different parts of the province, but in other villages the trade is strictly local. The looms are all very primitive. The

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wool, cotton, and silk are spun by men and women too old to do anything else, or by men working in the fields during spare time. Thus, if a fellah wants a new garment he will shear one of his sheep, spin the wool, and take it to a weaver.

Silk weavers at Damietta earn 1*s.* $2\frac{1}{2}$*d.* to 1*s.* $5\frac{1}{2}$*d.* a day, and they can weave twenty metres. The silk is first given to women to clean, 5 to 8 per cent. being rejected. The combings of silk are then put on the "konfiyeh," which is of light reed, cone-shaped, with a central spindle occupying the axle of the cone. From the "konfiyeh" the silk is rolled in two or more strands, ready for the cylinders of the "radei." These are put on the "doulab," and the silk is worked on to bobbins. Men who work the "radei" are paid 1*s.* $2\frac{1}{2}$*d.* a kilogramme, and they do one and a half kilogrammes a day. Women earn 1*s.* $0\frac{1}{2}$*d.* a kilogramme. At Manzala the raw silk used comes from China. A piece of rather coarse silk, 15·50 metres long, can be made in a day. The silk is dyed black before being woven, by soaking twenty-four hours in a bath containing pomegranate skins. A treatment with sulphate of lead and gall-nut follows, and it is then dried in the sun. In many localities the weaver's trade is hereditary.

At Beni-Adi excellent examples of hand-weaving in the way of "galibiyehs" are to be had. These garments are made of specially selected wool, and are very durable. They are sold by weight. Wool carpets are also made. This trade is in the hands of women. Both carpets and "galibiyehs" are sold by weight. They cost about 7*s.* a pound. There is a small carpet industry at Beni-Souef. At Abou Kerkas there are seven thousand inhabitants, and weaving is the chief industry. At one time all the thread was spun locally, now much is bought from Manchester. Stuffs of pure wool, seven metres in length and seventy-five centimetres wide, fetch 25*s.* locally. Pieces of mixed silk and wool, seven metres long and sixty centimetres wide, fetch three guineas. It is difficult to get exact figures, but a local merchant stated that 65,000 lbs. of wool thread, in the raw state, are sold for about £611 every year in the town, whilst 13,000 lbs. of thread, composed of mixed silk and wool, fetch about £408.

ARTS AND CRAFTS.

Stained Glass.—Stained glass windows nowadays do not, as a rule, evoke much enthusiasm, or, indeed, much comment of any kind. We generally hear more about how much they cost and whom they commemorate, than about the windows themselves and the person responsible for their design and execution. It is probably because Bunyan is a familiar household name, rather than on account of the undoubted interest of the glass itself, that the new window at Westminster Abbey has aroused as much attention as it has done. There is a tendency amongst the educated general public to cling tightly to the theory that the old methods of glass-making are lost, and that modern glass must inevitably be a thin and rather poor material, with little or none of the charm of colour which we find in old work. Just how far that idea is well founded it is, of course, rather difficult to say. It may be true that the chemical purity of the glass of to-day robs it of some of its unexpectedness and interest, but the beauty of colour of the old windows is undoubtedly due in great measure to the effect produced by the weather on the outer surface of the glass, and it is quite possible that two or three hundred years hence some of the best modern stained glass will, if it survives, have much the same quality that we admire in the old work.

Modern English stained glass may be looked upon as the outcome of the Gothic revival. It was that which gave the death blow to the eminently unglasslike windows of the early nineteenth century, and brought about a return to earlier and more workmanlike methods. Under its influence, the desire for pictures painted on glass died out, and a whole school of workers grew up whose ideal of glass was intimately connected with glazing. The windows they produced were by no means always satisfactory, and in their desire to make their glass look old and rich they occasionally overstepped the limits of honest workmanship; they were often hidebound by their Gothic tradition, and content to copy old designs and methods rather than try to develop them. But, when all that has been said, we must admit that the ordinary trade work of to-day is immeasurably better and more workmanlike than that of the Early Victorian period. Moreover, the very best windows that have been put up of recent years are not only good pieces of workmanship but real works of art.

The New Window at Westminster Abbey.—The technical interest of the Bunyan window lies in the fact that Mr. Comper, while adhering in a sense to traditional methods, has developed them. It was noticeable in the Sir Benjamin Baker window, put up under the direction of the same artist a short time ago, that the lead lines were unusually thin. In the Bunyan window we find this same thinness of line combined with a less ordinary and less strictly traditional form of design. The new lights are filled with large medallion subjects, separated from one another by spaces occupied by a diapering of delicate quarry work — an arrangement which makes them much easier to read than early medallion windows or even than some of the later subject windows to which they are in some ways more closely allied. Quarries, by the way, are hardly what one expects to find in a window planned like this one, and, though the method of the rest of the painting is quite in keeping with them, one is inclined to wonder whether some simple grisaille ornament on a larger scale would not have been more interesting, though it would possibly have been rather more costly. The thinness of the lead lines goes well with the delicate painting on the figures, and

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the harsh contrast between heavy leading and delicate painting, which rather shocks one at times in late fifteenth and sixteenth century glass, is thus done away with. Indeed, if there were no need to strengthen a stained glass window with additional supports, and if the ideal of a window is taken to be rather pictorial representation than beauty and brilliancy of colour, the Bunyan window would mark a really remarkable new departure. But, whatever our theories may be about the second point, saddle-bars are not theories but very solid facts. The lights at Westminster Abbey are broad, and it takes about twenty-four bars to each light adequately to support the glass; and to do their business properly, these bars have to be thick and heavy. In the ordinary way, the thickness of the lead lines, which for the most part run in a more or less upright direction (while the bars, of course, are horizontal), helps to balance the saddle-bars and to keep them from becoming unduly pronounced. When the leads are thin, the bars stand out with a startling prominence. Indeed, it is difficult to believe until one has counted them, that they are not more numerous in the new lights than in the other windows of the Abbey. Of course, the position of the new window makes it impossible to get a distant view; but looking at it from close at hand, as one is bound to do, one is inclined to think that thicker lead lines would have helped and not hindered the general effect of the window. After all, the painting might, without seriously affecting the result, have been a trifle less delicate, and the bars were a condition laid down by the exigencies of the case. So far as architectural drawings are concerned, modern architects may be quite justified in quarrelling with the good thick, vigorous line advocated by one of the leaders of the Gothic revival, but in dealing with a material like stained glass there is a very good use for it.

The Training of Craftsmen, Designers, and Teachers of Design.—There seems, at last, to be a decided movement towards the systematisation of the training of designers, teachers of design and skilled workers in the artistic crafts. The London County Council appears to be turning its attention to its trade scholars, and trying to bring the work in the technical schools more into line with workshop practice, an effort which ought to result in training a race of workmen who, whilst artistically better equipped than their forerunners, are no whit behind them in technical accomplishment. The trouble with the London trade schools has been very largely that the boys when they left them were not sufficiently advanced technically to enter the various trades as improvers, and were too old to be welcomed as apprentices or willing to take beginners' wages. If, by a certain amount of readjustment, the boys can begin their special training a little earlier, and be taught rather more of the technical part of their work in a way which fits them better for the workshop, there seems a good prospect of the schools fulfilling the functions for which they were created far more successfully than heretofore.

For the country, as a whole, the larger task of making new arrangements with regard to the design teaching in the schools of art has been undertaken by the Board of Education. The new conditions for examinations in art and certificates for teachers of art put out by the Board have, of course, a very intimate connection with the teaching of design. How far the new arrangements will bring down the numbers of students in the schools, and from that point of view affect them adversely, is a question which only teachers can be expected to answer. But probably few people interested in art will regret the passing away of the present machinery for awarding teachers' certificates.

Apparently after this year the Board only intends to examine serious students who have studied drawing for at least two years, whilst students who wish to pass in painting, modelling, or pictorial design, will be expected to study for a further period of two years. In the case of design students, an examination is contemplated of "such a standard as could be attained through regular attendance at evening and other part-time classes in the intervals of employment for a period of four years after the age of sixteen." But the candidates in this subject will not be obliged to sit for the drawing examination first. Teaching certificates will, when the new regulations come into force, only be given to students who submit evidence of having received a sufficiently good general education, and of having been trained in the theory and practice of teaching, and who have gained the Board's certificate in drawing and one other subject, or passed the final examination of the Royal Institute of British Architects in architecture. The new scheme seems in many ways a very great improvement on the old one, but it hardly appears to encourage design students to sit for the examinations at all since, apparently, their certificate when they have gained it, not being accompanied by a certificate for drawing, will not entitle them even when they have fulfilled the other necessary conditions to hold positions as teachers. Students seem to like examinations, or, at any rate, certificates, and there is a feeling abroad that the withdrawal of the more elementary examinations of the Board may necessitate the substitution of other tests of some kind in order to keep up their interest; but it is difficult to see why a designer wants a certificate of the nature of those to be issued by the Board under the new arrangements, unless he is going to teach. If the new certificates will not enable him to do that, it is not very obvious how it will benefit him. If this arrangement comes into working order unchanged it seems as though practical designers and craftsmen will be rather hardly used, and the teaching of design is likely to pass into the hands of people who are qualified teachers rather than qualified designers. It is surely a right instinct which has kept the authorities from forcing designers through the same course of

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drawing as students who are studying from a totally different point of view. But why not carry the idea a little further, and allow these students to be taught by masters who also regard drawing not primarily pictorially, but from the standpoint of design? As the scheme at present stands, it would seem that, if persons were admitted as teachers who had passed in design instead of in drawing, and in one other subject, the design teachers would have a less severe training than the other art teachers; but surely any lowering of standard could be guarded against by requiring evidence of practical working experience.

CORRESPONDENCE.

ILLUMINATED MANUSCRIPTS.

In the matter of the admirable letter by the lady who signs herself MacIver Percival in our *Journal* of this date, I am able very pertinently to support her view of the extreme difficulty, notwithstanding their seeming ease, of the feats of interlaced wire-work to which Sir Walter Armstrong referred in the discussion on Mr. Davenport's paper anent "Illuminated Manuscripts," published in the *Journal* of the 2nd inst. Among the Dravidas of Central India, and the Mongolo-Dravidian Bengalis, not only armlets and anklets are made of bent, and twisted, and interlaced wire, but the smaller household images of the gods are often fashioned of it, and, now and again, so picturesquely as to be aesthetically impressive. It all looks most simple, until you try to imitate these masterpieces of manipulative dexterity; when you find it to be just as impossible as to build the "Weaver-bird's" [*Ploceus Baya*], or the "Tailor-bird's" [*Orthotomus longicauda*] miraculous nests; and for the reason that the magistery of them all—idols and bird's-nest—is "the long result" of practice in the art and craft of interlacing, transmitted from parents to their offspring, through countless generations. "Ars est celare artem." But again, and it is the very first of the aphorisms of Hippocrates: "Ars longa, vita brevis." This is the leading lesson to be learned of the hereditary handicraftsmen of India, and the East generally, by the manufacturers—wrongly so named—of the "applied arts" of Europe; while Europe, on its side, thanks to its inheritance in the traditions of Phidias, Praxiteles, and Lysippus, and of Apelles, Parrhasius, Timanthes, and Zeuxis, is the natural teacher of India in the "fine arts,"—architectonic, lithurgic, plastic, and graphic.

GEORGE BIRDWOOD.

February 9th, 1912.

NOTES ON BOOKS.

THE NATURAL HISTORY OF CLAY. By Alfred B. Searle. Cambridge: At the University Press. 1s. net.

This little volume forms part of the well-known series of Cambridge Manuals of Science and Literature. It is divided into six chapters, dealing respectively with the chemical and physical properties of clays; clay and associated rocks; the origins of clays; the modes of accumulation of clays; some clays of commercial importance; and clay-substance, theoretical and actual. It also includes a bibliography, which will be of much service to those who wish to study the subject in greater detail.

It will hardly be necessary to remind readers of the *Journal*, in which Mr. Searle's Cantor Lectures on Brickmaking appeared in 1910, that the author is a recognised authority on clays of every description. He writes in a clear and simple style, and contrives to give an excellent account of his subject in a very small compass.

READINGS IN ENGLISH HISTORY FROM ORIGINAL SOURCES. Book IV. Edited by R. B. Morgan, M.Litt., and E. E. Kitchener, M.A. London: Blackie & Son. 2*s*. 6*d*.

These volumes, of which the fourth has just been issued, consist of "selections from original and (wherever possible) contemporary sources, illustrating the chief events in English history, and arranged chronologically." There seems to be a good deal to be said in their favour. They are, of course, open to the obvious objection that they are "snippety"; but it may be doubted whether the ordinary schoolboy's knowledge of history is ever more than this, even if it is as much. In the present volume, which covers the period 1688-1837, we have some fifty passages, including Marlborough's account of the battle of Blenheim, Clive's account of the battle of Plassey, Wellington's account of Waterloo, the birth of Methodism by Wesley, and a description from the Creevey papers of a terrifying journey in one of the first trains, when Mr. Creevey was whirled along at the frightful pace of twenty-three miles per hour.

The passages seem to be carefully selected, and judiciously varied to represent different phases of social as well as political history. They certainly do something to put a little flesh on the dry bones of the ordinary school history manual, and it is even possible that here and there a boy may be found who may be induced by the reading of these extracts to dip a little more deeply into the original authorities.

GENERAL NOTES.

LONDON SCHOOL OF TROPICAL MEDICINE.—A meeting will be held at the Mansion House on Wednesday, February 28th, at 3 p.m., to hear a report in regard to the work and progress of the school. The meeting will be under the presidency of the Right Hon. Sir Thomas Crosby, M.D., Lord Mayor of London, who will be supported by the Right Hon. Lewis Harcourt, M.P., Secretary of State for the Colonies, and others.

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Members of the Royal Society of Arts, who are interested in the school, are invited to attend the meeting. Those who intend to be present are requested to apply for cards to Mr. P. Michelli, Secretary of the Seamen's Hospital, Greenwich, S.E.

MEMORIAL TABLETS. — A memorial tablet has been affixed by the London County Council to No. 28, Newman Street, Oxford Street, which was for forty years the home of Thomas Stothard, painter and book-illustrator. The house was purchased by him in 1794, the year in which he was elected a Royal Academician, and he continued to reside in it till his death in 1834. A tablet has also been affixed to No. 8, Canonbury Square, N., the house in which Samuel Phelps resided during his management of Sadler's Wells Theatre. The scene on the opening night, when Phelps produced *Macbeth*, is described in a well-known passage by Dickens. "It was performed amidst the usual hideous medley of fights, foul language, catcalls, shrieks, yells, oaths, blasphemy, obscenity, apples, oranges, nuts, biscuits, ginger-beer, porter, and pipes—pipes of every description were at work in the gallery, and pipes of all sorts and sizes were in full blast in the pit. Cans of beer, each with a pint measure to drink from (for the convenience of gentlemen who had neglected the precaution of bringing their own pots in their bundles), were carried through the dense crowd at all stages of the tragedy . . . Fish was fried at the entrance doors. Barricades of oyster-shells encumbered the pavement. Expectant half-price visitors to the gallery howled defiant impatience up the stairs, and danced a sort of carmagnole all round the building." Dickens also gives an account of the steps taken by the new manager to reduce this chaos to order, and so successful was he that "within a month the Jack Ketch party, thoroughly disheartened and amazed, gave in; and not an interruption was heard from the beginning to the end of a five-act tragedy!"

A RAIL GAUGE.—A patent has just been taken out by Mr. T. B. Grierson, M.Inst.C.E., for a new method of weighing rails in the permanent way. The gauge consists of two arms firmly pivotted, and made to embrace exactly the head of the rail. It carries a slide and sliding rod, the sliding rod being divided on one side to indicate pounds weight per yard, and on the other side to parts of an inch to show the rate of wear. The method of use is this: the place to be gauged is brushed clean with a steel brush; the gauge is applied to the rail head, and held firm while the slide rod is pushed down, until it touches the head of the rail; it is then clamped by means of the milled head, removed, and the reading is taken, which will indicate the number of pounds per yard weight of the rail. This takes less than a minute to do. The advantages claimed for the gauge are:—(1) The rate of wear and the resulting weight of the rails per yard can be ascertained in a moment, without removing them from the permanent way; (2) rails can be weighed or measured at any time without stopping the traffic or working single line as at present; (3) the life of the rails will be lengthened without any risk, by leaving them in the road until they are worn down to the line of maximum wear, shown on the rail gauge; (4) the gauges can be applied to any section of rail and to all kinds of permanent way, including tramways; (5) in addition to the enormous saving which will be effected by the use of this method, and in the maintenance of the permanent way, there will be an increase in the traffic receipts by the doing away with the stopping of goods and passenger trains for the purpose of weighing the rails, as at present.

THE HOTEL INDUSTRY ON THE FRENCH RIVIERA.—A recent report published in the *Riviera Hôtelière*, a journal devoted to the interests of the "Union Régionale des Syndicats Hôteliers de la Côte d'Azur," gives some interesting statistics respecting the hotel industry on the French Riviera. From this it appears that the total number of hotels in this district, which extends from Toulon to the Italian frontier at Ventimiglia, embracing a coastline of upwards of 120 English miles, is 577. This does not include hotels with fewer than 20 rooms, or boarding-houses. Of this number, 66 are at Mentone, 91 at Monaco, 170 at Nice, 71 at Cannes, 31 at St. Raphael, whilst the remainder are scattered in other smaller places. The total capital engaged in this industry is stated to be 640 million francs (£25,600,000). This probably is beyond the true value, for it is well known that many of these undertakings are over-capitalised. With regard to the nationality of the proprietors, 20 per cent. are French, 10 per cent. Italian, 25 per cent. German, and 45 per cent. Swiss. A still larger proportion of the employees and servants are of the latter nationality.

PUBLIC WORKS IN TRIPOLI.—The works for the improvement of the port of Tripoli are to be carried out at once. The first part, which is to be completed by the end of this year, includes the construction of a breakwater 625 metres (687 yards) in length, to be built on the reef or line of rocks which affords the only protection to this port at the present time. This contract, which will be carried out by a well-known Italian firm, amounts to two million lire (£80,000), and also includes some other works of less importance. Further contracts will be given out shortly for the construction of quays, dredging, etc., and form part of the scheme lately approved of by the Minister of Public Works for the improvement of this port. If this is carried out, Tripoli will become one of the best ports on the North African coast. Extensive harbour works will also shortly be commenced at Benghazi.

THE MINERAL WEALTH OF ALASKA.—The value of the mineral production of Alaska in 1911 is estimated at £4,500,000, of which £3,500,000 was of gold. The gold production in 1910 amounted to £3,250,000. The copper output is estimated at

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23,000,000 pounds in 1911, against 4,200,000 in 1910. Alaskan mines and quarries also produced silver, tin, coal, marble and gypsum, to an estimated value of £80,000, an increase of £40,000 over 1910. The total value of Alaska's mineral production since 1880, when mining first began, is in round numbers £42,000,000. Of this amount £40,000,000 represents gold, and copper £1,600,000, the mining of the latter metal having been begun about ten years ago. Aside from the increase of copper mining, the advance made in the development of gold-lode mines was the most encouraging feature of the year 1911. The most notable advances in lode mining were made in the Juncau, Valdez, Kenai Peninsula, Willow Creek, and Fairbanks districts. Dredge mining also made great progress, particularly in the Nome region. At the close of 1911 there were 465 miles of railway in the territory, compared with 371 miles in 1910. The most urgent need at present is for a railway to connect an open port on the Pacific with the Yukon Basin.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 21.—Frank Warner, "The British Silk Industry and its Development since 1903." Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., will preside.

February 28.—H. A. Roberts, M.A., Secretary of the Cambridge University Appointments Board, "Education in Science as a Preparation for Industrial Work." Principal Sir Henry A. Miers, M.A., D.Sc., F.R.S., will preside.

March 6.—T. Thorne Baker, "Some Modern Problems of Illumination: The Measurement and Comparison of Light Sources."

March 13.—Professor Ernest A. Gardner, M.A., "Greek Sculpture."

March 20.—F. Martin Duncan, "The Work of the Marine Biological Association." P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., will preside.

March 27.—Theodore E. Salvesen, "The Whaling Industry of To-day."

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Loudon M. Douglas, F.R.S.E., "The Meat Industry." Three Lectures.

Syllabus.

Lecture III.—February 19.—The Pig and its Products.

Luther Hooper, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

Syllabus.

Lecture I.—February 26.—*Primitive Looms and Spindles: Prehistoric, Ancient, and Modern.*—The loom and spindle almost universal—Modern spinning and weaving machinery all constructed on ancient principles—Traces of prehistoric spinning and weaving—Simplicity of primitive tools and appliances—The simple textures of prehistoric cloth—The simplest loom and its essential parts—Modern and prehistoric webs compared—The spindle of all time—Advantages of *distaff and spindle* spinning—Modern distaff spinners—Spinning wheels—Peculiarity of primitive and ancient European looms—Greek and Egyptian methods of weaving—Egyptian, Persian, Roman, Brussels, and modern French and English tapestries.

Lecture II.—March 4.—*The Handloom for Automatic Weaving, Plain and Ornamental, and the Modern Spindle.*—Leonardo da Vinci's sketch of the spinning wheel *flier* and *bobbin* attachment—Its general adoption in Europe for hand spinning—Varieties of the motion developed—Inventors of spinning machinery—Hargreave's *Jenny*, Arkwright's *Waterframe*, Crompton's *Mule*, and others—Weaving in ancient China—Horizontal looms—Indian looms—Old English and other looms for silk weaving—Chinese silk loom—Invention of satin weaving—Looms for weaving small designs—Double *harness* weaving—Long- and short-eyed *leashes*—Chinese *draw-loom*—The *comber board*, its great importance—The *pulley box*—The tail of the loom—The *simple*—The *tie-up* of the design—The *divided* comber board and other arrangements for *tissue* weaving—European draw-looms—Examples of draw-loom woven textiles of various periods.

Lecture III.—March 11.—*The Modern Loom for Plain and Ornamental Weaving and its Future Development.*—Eighteenth century inventions compared with those of earlier periods—The drawboy—The drawboy machine—The Jacquard machine or *draw-engine*—Kay's *fly shuttle*, its great utility and unexpected value—The first power-looms—Application of steam power to the loom—General adoption of the factory system in textile industries—Comparison of hand and power-looms as regards quality and speed of weaving—The effect of machine weaving on the workers—Defects of the power-loom—Electricity as applied to the loom—The loom of the future.

Noel Heaton, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

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HOWARD LECTURES.

Monday evenings, at 8 o'clock :—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced :—

CHARLES C. ALLOM, "The Development of Artistic Skill in the Applied Arts."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

E. D. MOREL, "British Rule in Nigeria."

GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

GEORGE FLETCHER, "Technical Education in Ireland."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Loudon M. Douglas, "The Meat Industry." (Lecture III.—The Pig and its Products.)

Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. W. W. Greg, "What is Bibliography?"

East India Association, Caxton Hall, Westminster, S.W., 4.30 p.m. Mr. S. S. Thorburn, "Peasant Scholarships *versus* Patchwork Compulsory Education for India."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. Warren, "Collegiate Architecture."

Victoria Institute, 1, Robert-street, Adelphi, W.C., 4.30 p.m. Mr. S. T. Klein, "The Real Personality or Transcendental Ego."

TUESDAY, FEBRUARY 20...Royal Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. 1. Mr. T. T. Williams, "The Rate of Discount and the Price of Consols." 2. Mr. R. A. Macdonald, "The Rate of Interest since 1844."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C. Discussion on "Shoplighting," to be opened by Mr. N. W. Prangnell (Metropolitan Electric Supply Co.) and Mr. A. E. Broadberry (Tottenham Gas Co.).

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture VI.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Mr. F. Shelford, "Some Features of the West African Government Railways."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. A. T. Masterman, "Notes on Age-determination in Scales of Salmonoids, with special reference to Wye Salmon." 2. Dr. H. Lyster Jameson, "Studies on Pearl-Oysters. I.—The Structure of the Shell and Pearls of the Ceylon Pearl-Oyster (*Margaritifera vulgaris* Schumacher), with an examination of the Cestode Theory of Pearl Production." 3. Mr. Robert Shelford, "Mimicry amongst the Blattidæ; with a Revision of the Genus *Prosoplecta* Sauss." 4. The Rev. O. Pickard-Cambridge, "Contributions to the Knowledge of the Spiders and other Arachnids of Switzerland."

WEDNESDAY, FEBRUARY 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Frank Warner, "The itish Silk Industry and its Development since 1903."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. C. F. Rousselet, "Fourth List of New Species of Rotifera since 1889." 2. Mr. E. J. Spitta, "On the Colouring of Lantern Slides."

United Service Institution, Whitehall, S.W., 3 p.m. Lieutenant-Colonel J. Campbell, "Infantry in Battle."

Royal Society of Literature, 20, Hanover-square, W., 4 p.m. Professor Henry Newbolt, "Poetry and Rhythm."

London School of Economics and Political Science, Clare Market, Kingsway, W.C., 5 p.m. Mr. Ben H. Morgan, "The Trade, Industry, and Finance of the British Empire." (Lecture III.) 7.15 p.m. Mr. H. C. Cameron, "The Economics of the Refrigerated Food Supply of Great Britain, with Special Reference to Distribution." (Lecture I.)

THURSDAY, FEBRUARY 22...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. M. H. Spielmann, "The Portraiture of Shakespeare." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. W. C. F. Anderson, "The Geography of Hell, Pictorial and Poetical."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Messrs. J. C. Macfarlane and H. Burge, "The Supply and Transmission of Power in Self-contained Road Vehicles and Locomotives."

China Society, Caxton Hall, Westminster, S.W., 8.30 p.m. Mr. E. C. Wilton, "With the Mission to Lhasa."

FRIDAY, FEBRUARY 23...Royal Institution, Albemarle-street, W., 9 p.m. Mr. G. R. B. Elphinstone, "The Gyrostatic Compass and Practical Applications of Gyrostats."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. W. T. Douglass, "Works for the Prevention of Coast Erosion." (Vernon-Harcourt Lecture II.)

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, FEBRUARY 24...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Molecular Physics." (Lecture I.)

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m. (Graduates' Section.) Mr. A. P. Patterson, "Vessels for Carrying Oil in Bulk."

Correction.—Lieutenant-Colonel Sir Charles Bedford, I.M.S., asks that the following corrections may be made in the figures given in the report of his remarks in the discussion on the paper, "The Influence of Ozone in Ventilation," by Drs. Leonard Hill, F.R.S., and Martin Flack (see *Journal* of February 9th, 1912, p. 352, col. 2):—In the sentence "Hartley found that $\frac{1}{50000}$th part of ozone was perceptible to the senses," for the fraction "$\frac{1}{50000}$th" read "$\frac{1}{2500000}$th." In the sentence "The ordinary proportion of ozone in air was something like $\frac{1}{100000}$th of the volume of air, and it had been found that $\frac{1}{1100}$th to $\frac{1}{1200}$th of a milligram of ozone per litre constituted, for certain therapeutic purposes, an innocuous dose," for the fraction "$\frac{1}{100000}$th" read "$\frac{1}{70000}$th"; for the fraction "$\frac{1}{1100}$th" read "$\frac{11}{100}$ths"; and for the fraction "$\frac{1}{1200}$th" read "$\frac{12}{100}$ths." Sir Charles Bedford further adds that the figures given were not obtained by him, but were quoted from various writers on the subject.

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Journal of the Royal Society of Arts.

No. 3,092. VOL. LX.

FRIDAY, FEBRUARY 23, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 26th, 8 p.m. (Cantor Lecture.) LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." (Lecture I.)

WEDNESDAY, FEBRUARY 28th, 8 p.m. (Ordinary Meeting.) H. A. ROBERTS, M.A., Secretary of the Cambridge University Appointments Board, "Education in Science as a Preparation for Industrial Work." SIR HENRY A MIERS, M.A., D.Sc., F.R.S., Principal of the University of London, will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE ON "THE MEAT INDUSTRY."

On Monday evening, February 19th, MR. LOUDON M. DOUGLAS, F.R.S.E., delivered the third and final lecture of his course on "The Meat Industry."

On the motion of the Chairman, COLONEL SIR JOHN SMITH YOUNG, C.V.O., a vote of thanks was accorded to the lecturer for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

CANTOR LECTURES ON "THE CARBONISATION OF COAL."

The Cantor Lectures on "The Carbonisation of Coal," by Professor Vivian B. Lewes, have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, February 8th, 1912. SIR FREDERIC W. R. FRYER, K.C.S.I., formerly Lieutenant-Governor of Burma, in the chair.

THE CHAIRMAN, in introducing the reader of the paper, said it was hardly necessary for him to introduce Sir Thomas Holdich, because he was well known to everybody present either personally or by reputation, and by his writings. At the present moment the subject of the North-East Frontier of India was one of great prominence, partly in consequence of the occupation of Tibet by the Chinese, and by the pressure they had brought to bear on the tribes on the British side of the North-East Frontier, and partly in consequence of the Abor Expedition. He thought the members of the Society were very fortunate in being privileged to hear a paper from the author on the North-East Frontier of India, as he was an exceptional authority upon the question, and anything that he said was sure to be of very great interest.

The paper read was—

THE NORTH-EASTERN FRONTIER OF INDIA.

By COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.

So little do we hear in England of the North-Eastern Frontier of India that when the news came of the total annihilation of a mission to the Abors, few people knew who the Abors were, or what we had to do with them. And yet this remote corner of our Indian Empire possesses an interest, political and scientific, which is almost unique. Politically, it is here that the dividing line exists between the Chinese Empire and our own. Here is the hedge over which we may look, but which we may not pass; and here we may discern what the expansion of another great empire may effect in the matter of approach to our domains, and of control over

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a horde of Mongoloid peoples who have direct relations with ourselves and whose goodwill as frontier neighbours we cannot ignore. The scientific interest covers so large a space that it is impossible to deal with more than a section of it in one short paper. In the first place it includes a geographical area where there are still many problems unsolved, in spite of the fact that we have a grasp of the main features of its conformation. Gradually, year by year, we have traced out the waterways of the great Asiatic rivers which enclose this butt-end of the Tibetan plateau land. We have traced them out on general lines, but we have not surveyed them. We know where they must be, but we have not always seen them, and we still have to learn their value in the great scheme of inter-communication which these valleys afford.

As a field of ethnographical study I can only compare this land of magnificent altitudes and grand natural features with the land of the Kafir in the far North-West. Here, again, is an inaccessible region which has become the last refuge of the flotsam and jetsam of aboriginal Asiatic humanity, driven further and further into the wilderness by the inexorable laws of advancing civilisation and the survival of the fittest. Call that miscellaneous agglomeration of the relics of ancient tribes on the North-East by what name you will—Indo-Chinese, Indo-Burmese, or Tibeto-Chinese—they are the modern representatives of Mongoloid races who have long ceased to have any place in the scale of human development of Asia, and who really ought to be carefully studied as original types, or at least as primitive forms of humanity, ere they pass away altogether from the world's great stage. Time after time has the attention of the Government of India been drawn to the necessity for systematic research in this fascinating field of inquiry, and more than one Orientalist has broken the ground for a comprehensive and systematic study of them hereafter (notably Colonel Waddell, of the Indian Medical Service), but so far the impossibility of free movement amongst the most obstinately hostile of these tribes has barred the way to further progress. But no thirst for scientific information would altogether justify such an expedition as that, for instance, which is now being carried through the Abor country; and without such expeditions we shall never learn the truth either geographical or ethnological. When we are actually brought into contact with these unruly and wholly irresponsible savages, it is through the absolute necessity of maintaining order on our borders and protecting our own people in their homesteads and plantations of the plains. Experience on the North-West Frontier has taught us that the only way to secure immunity from the raids and robberies of turbulent and independent tribespeople, who have little to lose and much to gain by brigandage and murder, is to walk through their country, to hunt out their strongholds, and, if possible, to get beyond and behind them. Where their back doors, as well as their front doors, are commanded trouble ceases, but it is not much of the North-East Frontier that can be secured in this way. We must also bear in mind that it is from the extremity of our North-Eastern Frontier that there extends eastwards and southwards the line of least resistance for future land connection with China and Burma.

So far as China is concerned we need trouble ourselves no further as to the value of that frontier line which the Chinese (as I will show you) have already made their own; but as regards Burma it is impossible to look to a long future without the conviction that India and Burma will eventually be linked by a railway which will render a complete command of all contiguous tribes a political necessity.

What do we know as the North-East Frontier of India? Of what does it consist? Just as the Indus, with the rising steps of a mountain system leading up to a plateau land beyond it, marks the main feature of our North-Western Frontier, so does the Brahmaputra, from its outflow through the deep gorges of the hills north of Sadiya till it turns southward into the plains of Bengal, combined with the broken ridges of the Himalayan rampart to the north, embrace the great physical area of the North-East Frontier. These two magnificent rivers—the Indus and the Brahmaputra—start from the same cradle of the Tibetan mountains, and, sweeping outward in deep grooves to the north-west and south-east, they enclose within their mighty arms the whole of the Himalayan mountain system as now recognised geographically.

Beyond the Indus to the north-west we call the mountains trans-Himalayan. Beyond the Brahmaputra to the north-east (the country with which we shall deal presently) we have an extension of the great uplift of Tibet, scored with deep-cut waterways and seamed with magnificent ranges and ridges, which have yet to be adjusted in our maps. The valley of the Brahmaputra is, speaking broadly, the province of Assam, the province which we know as the home of many a profitable plantation, and a

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population both native and European lying more apart from the social and commercial life of the rest of India than any other province in the Indian Empire.

Through this valley of agricultural wealth flows the stately river for 450 miles in a broad and usually placid sheet of water, exhibiting every variety of river action in the formation and destruction of land on a truly gigantic scale. Here the silt washed down from the Himalayas accumulates in masses of mud, extending the banks or forming into new islets on the basis of some casual obstruction; there the river breaks away from recognised channels, and wanders with uncontrollable irresponsibility into new waterways, rendering navigation uncertain and dangerous, and forming loops which almost rival the main stream in volume. As with the Indus, so with the Brahmaputra, constant accretions of silt on its bed have gradually raised its level, so that the bordering strips of swamps and morass are constantly submerged; but beyond them again the ground gradually rises into gentle grades to the foot-hills of the mountains on either side. With the rugged plateaux and broken hills of the mountain systems south of the Brahmaputra we have nothing to do just now. These are the homes of the Kasia and Garo tribes, who may rightly be classed with North-East Frontier peoples; but we shall have quite enough to do if we confine our immediate interests to the Nagas, who occupy the hills south of the river near to the Burmese frontier, and to all the troublesome folk who people the northern hills of the Assam valley to the east of Bhutan: the Akas, Daflas, Abors, Miris, and Mishmis (not to trouble you with any but the best known tribal names). It is because we know so little about these people that I desire to draw your particular attention to them, for these are the people and this is the land which constitute our North-East Frontier. The physical character of this borderland, however, varies little, and if we take Bhutan as typical we may very safely infer that the general character of the Bhutan conformation is more or less repeated throughout the south-eastern edge of the Tibetan highland to the east of it.

Approaching the hills from the south one is immediately faced with the dense forest growth of the Tarai, interspersed here and there with vast spaces of reedy flats, where the grass grows twenty feet high and the track of the buffalo or elephant affords the only possible means of exploration. Many a weary day have I spent in the endeavour to outflank these deadly grass jungles in order to carry a connected line of surveying past them. They are impassable without the assistance of an elephant. Where grass ceases forest commences, and although these forests do not exhibit the magnificent array of creepers and the wealth of palms and flowering plants which distinguishes Central and South American forests, they glory in the same feature of gigantic trees towering hundreds of feet above one's head, well supported by a force of bamboo thickets and jungle of minor growth, which it is absolutely impossible to penetrate. Rapid movement through these lower forests is impossible except on the rare occasions when one strikes a native footpath. As the greasy, uneven, rain-sodden track winds uncomfortably up the lower spurs to higher altitudes the character of the forest changes somewhat. The trees are of more moderate dimensions; only the bamboo increases, and at intervals tree-ferns and other easily recognisable sub-tropical plants occur, crowding and drooping over the mountain streams and decorating cascades. Animated nature asserts itself in the form of innumerable leeches, and these ubiquitous pests can penetrate anything except a stoutly-twisted putti. Bamboos specially crowd the valleys, and at 6,000 feet or so you may have the luck to look down from a height into the blue depths of a gully, where a heavy fall of snow has, perchance, taken up the curving threads of the bending bamboo, and woven a pattern of white lace over the hillsides as lovely as the silvery fall of an ice-bound cascade. At 4,000 feet or so we find the first clusters of wood-built hamlets, the early signs of permanent habitation. So far we have been climbing up the first steps of the gigantic natural staircase which leads to the great Asian plateauland. If we regard the Himalayan system as forming the wrinkled and corrugated edge of the Tibetan tableland, and presenting, in their original and primitive form, a succession of parallel barriers, or steps, leading from the plains to the plateau, we should expect here and there to encounter certain landings, or flats, dividing, as it were, successive flights of stairs till we reach the top. This is practically what happens along the whole line of the Eastern Frontier, although the conformation is by no means as well marked as it is in the far North-West. The original great scheme of Nature in thus fashioning the approach to the roof of the world is recognisable from the Indus to the Brahmaputra, but in the matter of physical aspect, due to the difference of climate, no greater contrast can be conceived than that

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which exists between the barren and rock-bound and glacier-split barriers of the North-West and the more or less rounded and jungle-covered slopes of the North-East. Up to the altitude of 5,000 ft. or 6,000 ft. there is no break in the strength of the forest solitudes. Above that altitude, where human habitations are met with, the forest thins and varies in character. One wanders through an atmosphere of almost everlasting mist and cloud, amidst a weird array of gaunt, moss-covered trees with long grey beard-like parasites drooping and dripping rain-showers as they are gently stirred by the wind. It is beyond this again that we encounter the first rolling uplands with wide valleys and brawling streams, sweet grass-covered slopes covered with the glory of purple and white rhododendron, and clothed with flowers as with a Persian carpet. This is, indeed, a most lovely country, the last landing, as it were, on the Himalayan staircase before reaching the stern wide solitudes of Tibet. Physically, Bhutan is as much Bhot (or Tibet) as is all the country east of it bordering the Assam valley on the north. Politically and socially it is distinct. British India, as represented by the Assam valley, is bordered on the north by Tibet throughout. We recognise no distinct borderland of independent tribes, as we do on the North-West, when once we are east of Bhutan. But where Tibetan (in other words, Chinese) authority and influence end, and where British authority begins, we do not know. What has happened is this. The primitive Mongoloid inhabitants of this part of Asia, crushed in between the two gigantic and expansive forces of advancing Tibetan and Chinese civilisation, have been forced into the narrow spaces of the roughest and most inaccessible hills which border Assam, further advance south being barred against them by Indian occupation. I have spoken of Tibetan civilisation as a coercive power distinct from the Chinese, because in the past, when these great movements of Asiatic humanity were in progress, it was so. We hardly give sufficient credit to Tibet for its once dominant position in the world of Asiatic policy. Tibet has sent conquering armies into China and into India. Tibet has dictated terms to the Chinese Emperor, and, until its vigorous nationality was destroyed by the malignant growth of a debased and almost demoniacal form of Buddhism, Tibet stood as high morally in the roll of Asiatic nations as it stood physically. A reference to one concrete form of Tibetan civilisation in contrast to that of the savage Mongoloid tribes of the Assamese frontier will, perhaps, illustrate better than any other method the fact that, although we may write the word Tibet across these border hills north of the Brahmaputra, and to the east of Bhutan, we have little or nothing that is Tibetan to deal with when once we enter them.

From the magnificent series of photographs collected by the greatest living authority on Bhutan, Mr. Claude White, let me show you what Bhutan can rise to in the matter of architecture. For strength and utility, adaptability to site, and complete harmony with environments certain Bhutanese buildings may almost compare with the mediæval architecture of Europe, whilst in detail of decoration they are, of course, unique. It is not necessary to go to Lhasa to convince oneself that the Tibetan race belongs to the building races of the world.

We will now turn to the extreme north-eastern corner of our frontier, that point of the Assamese wedge which, in the present state of Indian affairs, is the part which matters most. The end of the Assam railway system is on the left bank of the Brahmaputra River, opposite Sadiya, which may be considered our most advanced station. There is a branch line from Makum junction to Margharita which is important. Some fifteen or twenty miles below Sadiya is the actual point where the Brahmaputra or Tsang-Po of Tibet, after issuing from the hills into the plains of Assam, takes its south-westerly bend; consequently Sadiya is on an affluent of the Brahmaputra, which affluent has formerly been recognised as the real source of the great river, and is called the Lohit Brahmaputra still. In order to have a proper understanding of the geographical problem of this extremity of the Indian Empire, it would be well first of all to take careful note of the names of the various rivers which unite there to form the volume of the great stream which slides so majestically through the valley of Assam, because these names bear a most unfortunate likeness to each other, and may easily be confused.

We know now that the main stream of the Brahmaputra comes from Tibet, breaking its way through Himalayan barriers, but until it has actually passed these barriers and reached the centre of the valley it is known as the Dihang. It is on the borders of the Dihang that the Abors live of whom we shall have something to say presently. Eastward of the Dihang is the Dibong, which drains from north to south through an unexplored corner of Tibet, although its lower reaches have been mapped by

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Woodthorpe and Ward. Its chief affluent is the Ikthan or Ithan. Next comes the lineal extension of the Brahmaputra, the Lohit Brahmaputra, on which stands Sadiya, leading directly to China. Not a hundred miles from Sadiya, on the Lohit, is the village of Rima, and at Rima the Chinese have recently established a frontier post. From Rima the road to China strikes off north-east over a series of high passes to Batang, which now must be reckoned as a Chinese town rather than Tibetan, and where, I believe, we may find the most advanced of the inland mission stations in western China. The river itself leads northward from Rima to the Tibetan plateau and Lhasa. From Batang to Rima and from Rima to Lhasa, the route has been traversed by that well-known native explorer who now lives in retirement as Krishna. From Sadiya to Rima various attempts to map the river have been made, and it is in this connection that the name of Needham is most prominent. It is impossible within the narrow limits of a paper like this to do justice to the names and memories of all the gallant officers and gentlemen who have distinguished themselves on the North-Eastern Frontier, but in the political field the name of Needham, political officer at Sadiya, stands out as does that of Woodthorpe in the field of exploration and survey. What Needham does not know about the North-Eastern Frontier certainly no one else knows. His connection with the wild, but not totally irreclaimable, savages of that remote corner of our Empire is one of the romances of the North-East. He nearly reached Rima, quite near enough to fix its position relatively to Sadiya. Turning south from the Lohit, we arrive at the Dihing which points south-eastwards to the foothills of the Patkoi range and the gateways of northern Burma. Thus we have the Dihang, the Dibong, and the Dihing in close juxtaposition, and uncomfortably similar in sound, all their names probably being derived from one and the same primitive native equivalent for the word "river."

It is with these waterways of the Brahmaputra, radiating as it were from the apex of the Assam valley, that we have chiefly to concern ourselves.

The Dihang, which is really the main stream of the river, connecting in one continuous channel the Tzanpo, of the Lhasa system, with the Brahmaputra of the Assam basin, concerns us chiefly, for it is the valley of the Dihang that affords the most obvious geographical opportunity for a direct connection with the most highly-developed provinces of Tibet, and it is in the wilderness of forest-clad mountains which enclose the Dihang that the Abors dwell, the people who have so persistently resisted all efforts to effect a passage through their narrow territory, and who have lately signalised their determined opposition to the interchange of friendly communication by the disgraceful treachery which marked the murder of Mr. Williamson and of his whole party. The opposition is easily explained and is perhaps natural, but the treachery which withdrew that opposition for a time for the purpose of entangling their friendly visitors in a position from which there could be no escape will, we trust, be properly punished. Westward of the Abors the hill country is occupied by the Miris, who extend into the forest-covered flats of the plains below the hills. The flat forest (or Tarai, as it is locally called) between the Dihang and Dibong, is practically uninhabited. Immediately west of the Dihang the hills are the home of the Passi-Meyong Abors; the Pangi Abors come between the Dihang and the Yamne; and the Bor Abors (Bor means "great") hold the hills from the Yamne to the Dibong. These three sections or clans of the Abor tribe are thus all of them people of the hills; the Miris, to the westward of them, are found both in the hills and the plains; and the Mishmis, a most important tribe that cannot be overlooked, occupy the basin of the Lohit Brahmaputra, to the east. We need not trouble ourselves about any other of these Mongoloid tribes at present. In general physique they are all alike, the Abors, perhaps, being the finest race. In tribal customs they differ considerably in detail, but in the outer barbarism of their methods, their savage lust for bloodshed, and their general indifference to the ordinary and natural laws of chivalry, even amongst savages, when dealing with women and children, there is little to differentiate them from the naked head-hunting Nagas of the southern Assam hills. Just to refer shortly to the details of the expedition which is now being undertaken against the Abors, you will observe that the base of it is at Kobo, near the junction of the Dihang and Brahmaputra. From Kobo one column has followed the line of the Dihang to Pasi Ghat, at which point the river debouches from the hills. A second column made its way westward to deal with the Pasi Meyong Abors, entering the hills somewhere near peak 2835 on the map, ultimately joining number one column at Kebang. It is with number one column that the interest of the expedition chiefly lies, for it

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is in connection with the operations of this column that we shall finally learn whatever geographical secrets there may yet be to be learned about that section of the Brahmaputra River between Tibet and Assam which has never yet been surveyed, but which has been explored both from Tibet and from Assam, so that there is not much of it about which we can say we know absolutely nothing. The story of its exploration from Tibet is one of the romances of the Indian Survey Department.

Kinthup (or "K.-P.," as he is known in the confidential archives of the India Office) was a native of Sikkim, and one of the native explorers of the Indian Survey. In the year 1880 he went forth armed with certain instruments and some careful instructions to trace the Brahmaputra from Tibet to Assam. He travelled with a Chinese lama, also an agent of the Survey Department, a doubtful sort of companion, who was the originator of all his troubles. Making their way by routes previously explored, they arrived in due time at Gyala Sindong, near the point on the river where it bends sharply from a north-easterly to a south-easterly channel. So far there was no great difficulty, the route lying on the right or southern bank of the river. With the bend there occurs an abrupt narrowing of the valley caused by the enclosing mountains which closely grip the river for some five and twenty miles, producing a series of rapids and falls. It is possible, however, to follow the left bank of the river fairly closely to a point about five miles above the principal falls (Sindi Chogyal), whilst from a point two miles below these falls there is a well-trodden route passing from village to village till it reaches the market-town of Miri Padam. On the right bank of the river there are also tracks, and it is to be noted that the capital of the district, Pema Koichung, is not far above the falls connecting the routes on either side; but it is clear that there is no route on either side which follows the stream closely past these falls. Below them there are routes or tracks on both banks passing through villages and cultivation, and presenting, apparently, no great difficulties to travellers. Kinthup's description of the valley, its cultivation (which includes rice, cotton, and fruit), its monasteries and sacred places, and the wild and savage Abors of the lower reaches is deeply interesting. The roads are mere tracks, rising over successive spurs and dropping again into the flats on the river border. Clearly we must look to two sections of the valley to account for the fall of the river from the Tibetan highlands (say 11,000 ft.) to the flats of Assam (say, 500 ft.), and these two sections are the rapids and waterfalls of the Gyala Sindong gorge and the final grip of the mountains below Kebang, that gateway of the hills which makes the advance of our force under General Bower a work of such supreme difficulty. Kinthup got no further towards Assam than Onlet, above Miri Padam, but his account of the generally open and easy nature of the valley between the falls of Sindong and Kebang is fully supported by the two Gurkha surveyors who made their way under Mr. Needham's direction in the spring of 1901 to Kebang by the right bank of the Dihang, and were there met by the determined opposition of the Pasi Minyongs, who blocked any further exploration most effectually. They maintain that the route from Kebang to Gyala Sindong (which they said they could see in the distance on a clear day) was absurdly easy compared to that which they had surmounted. They speak, indeed, of country "open and undulating," and the distance only ten stages. The falls are very sacred and the bourne of many a devout pilgrimage. Clouds of misty spray rise into the clear atmosphere above them, and a rainbow ever spans the valley. The scenery is magnificent. A dense sub-tropical jungle, rich with every variety of tree-fern and bamboo, reaches up the hill-sides to the limits of more open spacing, and a more stunted growth of rhododendron and oak. Above them are protruding glaciers and granite peaks, and towering above all the eternal snows and the everlasting silence of the ice-fields. I should like to tell you more fully about Kinthup, but time fails me—how he was sold into slavery and served his time under a Tibetan taskmaster; then, escaping, he was hunted through the valleys, claimed the protection of a monastery, and was again bought as a slave, and, escaping again, dug out his hidden instruments, and with no thought of turning back, set his face steadily to carry out the instructions of his master, Captain Harman. Finally he found a cave, and therein he completed the cutting and marking of certain logs, which were to float down the river to tell Captain Harman, who was on the watch in Assam, that the river where the logs started was one and the same with the Brahmaputra. Many a long day did the gallant Harman watch from his station for these wooden messengers bobbing along on the swirling tide of the great river—and at last he died there before they reached him. Kinthup knew nothing of this. He adopted the *rôle* of a pilgrim and made a fresh start. He

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explored a new route from his monastery on the Brahmaputra to Lhasa; again returned by other ways on his original quest, reaching south as far as Onlet, where he was stopped by the pig-headed obstinacy of the Abors within sight of Miri Padam. Eventually he returned by Lhasa, and turned up at the headquarters of the Survey Department in India after four years of patient research and most extraordinary adventure. His reports have been verified once and again, but his mapping, under the uncertain conditions of his work, certainly left something to be desired. That something we shall learn from my old friend, General Bower, when he comes back from dealing with Williamson's murderers. The man who pioneered the first European track across Tibet from west to east is not the man to come back from this unmapped corner of our North-Eastern Frontier with his work half-finished. General Bower is a good soldier and sportsman, but before all things he is a sound geographer.

A notable expedition into the Abor country as far as Kebang was made by Colonel D. M. Lumsden in January, 1909. He was accompanied by the ill-fated Political Officer, Mr. Williamson, and by Mr. Jackman, of the American mission, who can talk the Abor language "like a native." On that occasion they were guided by the *gam*, or head man, of Kebang from Pasi Ghat, where they entered the Abor country, and their welcome at Kebang, if rough and rather embarrassing, was, at any rate, sound. Beyond Kebang, however, they could not proceed. The excuse made was the existence of tribal war between certain sections of the Abors, which would make travelling unsafe, and they were in a position to verify the statement as correct. A notable personage in the Gam of Ren met them at Kebang, and addressed the Abors publicly. It is probable that the negotiations which then passed between Williamson and this chief led to the subsequent fatal expedition, for it was apparently through the treachery of this chief that the party were massacred almost to a man. It is to Colonel Lumsden that I am indebted for the few photographs of the Abor community which we possess.

The Dibong River drains an important section of the Mishmi country lying east of the Abors. It has been traced and mapped for some twenty or thirty miles above its debouchment from the hills from Nizamghat by Woodthorpe and Ward, and the general conformation of the hill country overlooked corresponds with that already described as the lower basin of Dihang. It is essentially upland deeply rifted by narrow waterways. The hills range up to an altitude of 15,000 ft., and are all covered by dense tree jungle. This invariable feature of the North-East Frontier is due doubtless to the excessive moisture in the atmosphere of the wettest corner of India. The monotonous persistency of rainfall during nine or ten months of the year is an unpleasant feature of the climate, which accounts for much of the difficulty of movement about the country. Our friends on the Abor expedition are suffering much from this infliction. It may be noted that on the southern edge of the hills south of the Brahmaputra, where the inrush of cloud-bearing currents sweeping inwards from the Bay of Bengal first strikes the mountains, the rainfall is such as to constitute a world's record. It averages about 60ft. a year—enough to float a Dreadnought!

The Mishmi paths are steep and difficult, and there is nothing within the areas surveyed to indicate anything like the open and undulating valleys that we have been told to expect beyond Kebang on the Dihang (or Brahmaputra). What may be beyond the limits of Woodthorpe's exploration we have yet to learn. We shall find eventually, I have no doubt, that the belt of wild jungle-covered, and almost inaccessible, hills is backed by more open uplands, and that it is the fringe of the mountains and the gorges of the great rivers bursting through it that presents the chief difficulty to exploration. The Dibong, however, so far as we know, leads to no ultimate line of international communication, and is so far comparatively unimportant.

It is otherwise with the Lohit Brahmaputra (or Zayal Chu), which drains the Tibetan province of Zayal ere it reaches the Chinese frontier at Rima. Rima is less than a hundred miles from Sadiya, and the way thereto is beset with the usual amount of weary struggle with slippery rocky paths and jungle-covered hill. I have already said that Needham very nearly reached Rima from Sadiya, and that the explorer Krishna did actually reach Rima from the other side. From Rima he effected an important discovery by following up the Lohit northward to its source, reaching the Tibetan province of Kham, and ultimately Lhasa, by that route. The significance of Rima lies in the military post which China has recently planted here. We are politically on the edge of China wherever we touch Tibet or the wild tribes that border Tibet, but nowhere is the practical advance of that irrepressible nation so distinctly marked as at

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Rima. What does it mean to us ? What is the real significance of this apparition of a yellow face looking over the border hedge into a corner of Assam ? I will not bore you by pointing out the reasons why, as a matter of military significance, it has no meaning at all ; I will merely indicate one at least of the conditions implied by that occupation. The Chinese do not dump down their military posts along their frontier without securing good and safe means of communication behind them ; so that we may well believe that the route followed by Krishna from Batang to Rima, crossing though it must a series of high passes, is a fairly useful road ; indeed, Krishna says it is. Batang, on the high road between Lhasa and China, is not more than 150 miles as the crow flies from Rima. At Batang, I believe, there is already a European mission station. I believe it because I know it was contemplated some time ago, and the missionaries are usually first on the field of practical geographical advance. The road thereto from Rima is very much longer than 150 miles—say 200—but it is evidently a sound route for purposes of military and commercial communication, and it is the straightest road to western China. The point of the position is this. If a Chinaman from Rima wished to explore Assam, we should not interfere with him. He might find a little difficulty with the Mishmis, but he would find none from us. We then have a right to demand reciprocity. If we, too, are prepared to take our chance with the Mishmis, who will not give trouble for long now that they are dominated from both sides, why should not we traverse the direct road to Batang and western China ? It has happened to me on another part of the Chinese frontier that the crossing of that frontier was immediately met by a hostile demonstration. I was politely, but unmistakably, made prisoner and marched back again. This, too, when I was actually assisting to determine a frontier in Chinese interests, so we may assume that there is not a prospect of our finding an open road beyond the Chinese door unless we insist on it as one of the conditions of Chinese occupation.

Yet another part of the North-Eastern Frontier must be touched upon. There are other ways of linking up India with China, which is one of the inevitable developments in the world's progress, than by taking the straight and narrow, but neck-breaking, path. We turn now to the Dihing. Not that the Dihing is in itself of any vast importance, but it points the way to Burma. We are now in the land of another primitive Mongoloid race, but a race possessing far more affinity with the Chinese. The Singphos are a section of the Indo-Burmese group who have in times past shown considerable activity and enterprise in enlarging their borders. They pushed across the intervening hills from Upper Burma into Assam, where they left their mark in the shape of the district name (Ahom or Asom), and where they are to be found still. Meanwhile a section of the irrepressible Nagas have thrust their way across the line of advance, and divide the Assamese Singphos from the Singphos of Burma. The Nagas, by the way, are not so irreclaimable as to be unaware of the value of the British rupee. They are the people from whom the leaders of the Abor expedition have recruited a most useful corps of carriers and jungle-cutters. They are a most interesting and bloodthirsty race, but time fails me to talk about them further.

The connecting routes between Upper Assam and Upper Burma have been thoroughly reconnoitred. There are three which offer possibilities for railway construction.

The story of the North-Eastern Frontier of India would be incomplete without a reference to that most important feature of it—the approaches and gateways to Burma. It is important for the reason that we might hereafter be sorely in need of a land route to Burma from India. Here we get back again to the old, old story of the command of the sea. We are never far from it in India ; and inasmuch as our hold on India is dependent thereon, you may probably object that if we lose that command we need trouble ourselves no further about a highway between India and Burma. But Britain still rules the waves, and there are other considerations, both political and commercial, which almost compel us to secure all the dominant power which such a right of way would give us. And it was with some such prompting as this, no doubt, that the Government of India wisely organised a series of surveying expeditions across the intervening hills, which should decide —and which have decided—where the iron way could best be carried. Of the three ways of getting to Burma from India, one is not an Assam route at all. This may be called the Aeng pass route. It follows the coast-line more or less from Chittagong southwards till it faces the easiest gap in the long extended mountain system of Arakan, which would allow of its divergence into the valley of the Irawadi, somewhere half-way between Rangoon and Mandalay. An expensive and difficult line. Then there is

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the Manipur route, which leaves the Assam valley to the east of Gauhati and Shillong, and, after winding through the hills and visiting the small and independent state of Manipur, would land the traveller on the Irawadi, about half-way between Mandalay and Bhamo. This has certain military advantages, especially in matters touching Manipur, but, once again, it is expensive and difficult. Thirdly, there is the Hukong valley route, which, starting from near the head of the Assam valley, twists its way to the foot-hills of the dividing range of Patkoi, and then, negotiating that range by means of a prospective tunnel, drops into the small beginnings of the Hukong River, terminating on the Irawadi at Mogaung, to the north of Bhamo. This is the true North-East Frontier route, inasmuch as it would cost about half that which the Manipur route would cost, and is in every way the easiest to construct and to maintain. It is, therefore, the route which we may confidently expect will be ultimately adopted in that good time when India is free to spend money on frontier developments. The total distance from the railway head in Assam of this route is a little short of 300 miles, of which about half runs through the rough dividing hills between the Assam valley and the head of the Irawadi affluents, and the other half may be reckoned as a surface line. There is only one formidable dividing range parting the two great river systems at this point—the Patkoi—which runs to about 4,000 ft. in altitude. A tunnel at about 2,700 ft. would not be a difficult or very expensive construction, and the drop into the Hukong is simple. On the Assamese side of these dividing hills the jungle is very dense. It has been explored by several good geographers, amongst others by Needham and Woodthorpe. The latter followed the line of the Dihing. The universal feature of eastern frontier exploration is the terrific labour involved in cutting a way through the close-packed vegetation that is massed in the valleys and stiffens the hillsides of all hill slopes below 6,000 ft. in altitude. There is no getting away from it. A footway cut out of the solid jungle one year will be as if it had never existed by the end of the following rains; and it is only because Nature has so fitted man to his environment, that the untutored savages of this corner of the Empire are most skilful artists when it comes to jungle-clearing and load-carrying, that the European is able to grope his way through the rocky tracks at all. A notable journey was made by Mr. C. E. Young a few years ago from Yunnan, in China, to Sadiya, on the Brahmaputra, passing more or less closely along the Hukong valley route; but we have in the records of the Government Railway Survey in 1895 and 1896 so full an account of the route and its environment as to leave little to be added by subsequent explorers. The Intelligence Officer responsible for the Surveys on that special mission was Captain (now Sir Eric) Swayne, who has since proved his capacity for geographical exploration in Somaliland and elsewhere. Passing the Patkoi range we are in a district of somewhat different race affinities to those of the Assam valley. The Singphos and the Khamtis of the Assam valley are cognate peoples of the same Indo-Chinese stock. It is a matter of history that some hundred years ago the Khamtis crossed into Assam from Upper Burma, and have remained there ever since. The Singphos of the Hukong valley own many Assamese slaves, whom they treat well, on the whole, and who complain of nothing except the inevitable break-up of families under the conditions of slave commerce. The Singphos are hardly to be reckoned with as a martial race, and the little opposition that they might offer to a permanent European institution amongst them (such as a railway) would be prompted far more by their fear of a movement against slavery, entailing consequent loss to themselves, than by any active feeling of hostility to the European. Such at least was the opinion formed by the railway route explorers of fifteen years ago, and such seems to be the opinion of, perhaps, the greatest authority on Burmese affairs, Sir George Scott, to-day. He pointed out in an able paper, read before the Colonial Institute in December last, that what the fertile valleys of Upper Burma want is population, and that population with commercial development can only be introduced by communication with India.

Isolated railways and railway systems in the East lose half their value and significance if they are not projected with the ultimate idea of creating and developing commerce over large and favourable areas, however much they may be built to satisfy the claims of strategy and administration in the immediate future. "Shreds and patches" of railways, as Sir George Scott calls them, are only locally useful. They will soon disappear in China in favour of a national system, and then we shall be face to face with this curious anomaly. There will be one huge isolated system in India; another system not so huge, but equally isolated in Burma; and a third in China. Between these systems there will be no connecting link to bind

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them to each other, or to bind India to Europe. Such a disjointment of the world's commercial interest cannot possibly last. There must be many here to-day who will live to see the linking up of Europe with India, and India with the remoter East, when it will be no longer necessary to take advantage of the enterprise of Russia in order to reach the shores of the Pacific from Western Europe; and the first link forged in the chain will probably be this of the Hukong valley.

One turns from the fascinating theme of the North-Eastern Frontier with something of regret. Doubtless there is more in the stirring atmosphere of the North-West to attract public attention, because it is there that we find the great bulwarks of India's defence, and it is there that we watch for the first shadow of those coming events which may affect the ultimate destinies of the whole British Empire; but, as a matter of sentiment, the call of the unknown and of the beautiful appeals more strongly from the North-East. It is not the large flat solitudes nor the cold craggy magnificence of icefields and snow-capped peaks of the North-West that first touch the chords of memory during the waking dreams of the shelved and antiquated Anglo-Indian official. Rather it is the butterflies and the birds, the wild beauty of Bhutan, or the deep, silent, tiger-haunted forests and savannahs of the mystical valley of the Brahmaputra.

DISCUSSION.

The Chairman (Sir Frederic Fryer), in opening the discussion, said that all present had listened with much interest to the graphic account of the North-Eastern Frontier given by the author, and they could now realise the nature of the country with which he had been dealing. The country was naturally one of great difficulty for surveyors. It was not only the physical features of the country that made it so difficult, but also the hostility of the inhabitants and the difficulties of transport. Those explorers who opened out such a country for the British people did so at very great risks, and incurred very considerable hardships. His own acquaintance with the North-East Frontier of India was principally confined to Burma. In Burma there had been several Boundary Commissions. In 1893 the boundary with Siam was delimited, and in 1895 the boundary of that country was delimited with France, which now was the Mekong River. There had been three years of boundary work by Commissions on the Chinese frontier; a considerable part of the Chinese boundary had been delimited, and the boundary had been marked out by cairns upon the spot. One gap was left in what was known as the Wa country, which was inhabited by a head-hunting and bloodthirsty tribe. When Sir George Scott, who was in charge of the British side of the Boundary Commission with China in 1900, was in the Wa country, three officers of the Commission went down to visit a market that was being held in a Wa village, and the natives fell upon them and killed two of the officers, Major Kiddle, of the Indian Medical Service, and Mr. Sutherland, of the Burma Commission. Mr. Lytton, who was the political officer of the Boundary Commission, very narrowly escaped with his life through the help of a Chinese sergeant. The Wa country had not yet been delimited, and though it was considered to fall within the British sphere of influence its administration had not yet been taken over. To take over the administration of a country inhabited by people like the Was was a very expensive thing. The country would have to be held by police posts; no revenue would be obtained, and for another thing it would be necessary to keep the Was in order. Beyond Bhamo the boundary was considered to be the watershed of the Salwin and the N'maikhah Rivers, and the Chinese had agreed that that should be considered the boundary. But it had never been actually delimited on the spot, and the Chinese were constantly trespassing across the border. In 1900, when the British Civil Officer was in that region on his winter tour of inspection, he was attacked by a large party of armed Chinamen. Fortunately he had an escort of seventy Ghurka police with him, and the Chinese had cause deeply to regret their boldness. Those sections of the frontier ought, no doubt, to be delimited. Although it was natural to suppose that the Chinese were already sufficiently occupied by their own internal troubles, as a matter of fact they were steadily encroaching on the British frontier; and unless the frontier was actually delimited, and this country was prepared to hold it in some force, the Chinese would always trespass across it. So far as the frontier actually delimited went, they observed it very well, and the Chinese officials met the British officials every year in the cold weather to settle any outstanding disputes. The great difficulty was to keep the tribesmen on the British side from attacking the tribesmen on the Chinese side, and *vice versa;* but any such cases were now dealt with by a joint commission of officers from both sides of the border, and so far things had worked very smoothly. With regard to the question of communication with India by railway, he believed that a line through the Hukong Valley would, as the author stated, be very easily made. The country was quite simple, and there were no very great natural obstacles. A proposal had been made to construct a line to T'êng-yüeh. A line could easily be made to T'êng-yüeh, but he had always understood the difficulty was to carry the line beyond that place. Engineers, however, could overcome all kinds of obstacles, and no doubt it would be possible for them to carry the line even beyond T'êng-yüeh; and there were, no

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doubt, other directions in which a railway might be still more easily made.

Colonel Sir Eric Swayne, K.C.M.G., C.B. (Governor of British Honduras), said that whilst listening to the paper his memory had gone back to sixteen years ago, when he travelled through the country to which the author had referred. The question of the railway was one which had a very tangible interest to a large number of those present. Personally, he believed a railway would have to be made some day. Speaking only of the railway going eastward from Assam into Burma, there were, in the Hukong Valley, some 1,200 to 1,500 square miles of very fertile land covered with forests, but there was hardly any population there. A railway was required to bring a population and develop the country. It was a rubber-producing country, the rubber being obtained from the big rubber trees, and great quantities of rubber had been exported during the last thirty or forty years, both into Assam on the one side and Burma on the other. Chinese traders came with Burmans from the side of Burma and penetrated right up to the Patkoi range, made their advances to the local people, who gathered the rubber and floated it down on rafts into Burma, or else they carried it across the Patkoi range and sold it in the Dibrugarh market. When he went up to the Patkoi range, canoes had to be employed to carry the party up the streams, while subsequently rations were carried on the backs of elephants through tunnels in the forest up to the foot of the Patkoi range, where Naga coolies were obtained. From the Patkoi range a splendid view was obtained over the Assam valley, right up the headwaters of the Brahmaputra, the whole range of the Himalayas being seen in the distance. In looking down upon the country in that way the whole of Assam was spread out before the traveller like a map. The plains were covered with dark forests, and the line of each river was very clearly marked, winding in a white band across the plains. The rivers were full of fish, and the place was a true fisherman's paradise. In one hour he caught 80 pounds of mahseer, consisting of 30, 20 and 10 pounders. The fish was of a good fighting kind, and he could strongly recommend the sport to anyone who was a true fisherman. Unfortunately, while he was travelling in the country, the coolies accompanying the party contracted cholera to start with, and later on scurvy and dysentery. A great many of the men were lost in that way, and the camps were marked by the graves of the men who were left behind. The jungles were very thick, it being necessary to cut their way through them, and it was also necessary sometimes to make bridges over the rivers. The coolies were excellent men for that kind of work. In many cases the party preferred to march down the river up to their waists in water, rather than go over the thick jungle-covered hills, on which it was only possible to march two or three miles a day. When the Hukong valley proper was reached everything was plain sailing. If a railway was built it would be absolutely necessary for the British to control the tribes in the Hukong valley. As far as he saw, there would be no difficulty in doing that, the tribes being well disposed towards us. The only difficulty that would arise would be occasioned by the slave question. Domestic slavery existed in the country. The slaves were well treated, but hardship existed in that they were liable to be sold to other masters, so that mothers were separated from their children. The slaves were well fed, but any excess of zeal on their part did not make for their own good, but the benefit of it went to the masters. If a railway was made, that matter would have to be taken in hand, but he hoped that it would be done very gradually, and that nothing drastic would take place. Probably it would be wiser to adopt a system similar to that adopted in Zanzibar, by means of which domestic slavery would automatically cease as time went on. If the slavery question was properly dealt with, no trouble would be experienced in administering the Hukong valley. The valley itself was very rich. It possessed amber mines, the amber being dug out of pits; while on the borders of the valley, towards Burma, there were jade and ruby mines. His party came across huts in the Hukong valley, on the banks of rivers, which contained wooden dishes with which the natives collected gold. A regular practice was not made of working the gold, but when there was nothing to be done in the fields the natives went to the rivers and washed up whatever gold had been brought down by the floods. Sometimes the more energetic went up to the headwaters of the river, where the sands had collected, and returned with quills full of gold. The country might, he thought, develop into a splendid rubber-producing property, and, taking it all round, it was a country which England could not afford to neglect.

Sir James George Scott, K.C.I.E. (late Superintendent, Southern Shan States), said the author was a great authority on the North-West Frontier of India, and his book, "The Gates of India," was most charming reading. He hoped now Sir Thomas Holdich had gone a little towards the north-east, he would go farther still and write a book on the whole North-East Frontier. In order to tempt the author to examine the North-East Frontier, he wished to say that there were some gates there already, although they were not such gates as tempted Alexander to come in from the West with the Greeks. Although they were called gates, possibly the average person would call them trap-doors, or manhole doors, or attic windows. When the question arose of delimiting the Burma frontier, the Chinese adviser to the Burmese Government discovered in the T'êng-yüeh annals that there were seven gates all named, and they naturally seemed to concern the frontier very seriously. A British party, therefore, went out to find those gates, but they discovered they were just as difficult to identify as the writer of the letters of Junius. They travelled in a country quite as nasty as some of that shown in the

photographs; they did a lot of Alpine climbing in a sort of palm-house temperature; they cut down a very great deal of jungle, and they took down the sworn depositions of a number of imaginative headmen. At first they thought that the leeches were the most disagreeable feature of the country, but before they had gone far they came to the conclusion that the blood-blister flies were still worse. The whole winter season was spent in the hills, and when they got back to headquarters the only thing they were quite certain about was that all men were liars. The Chinese also knew that there were the seven frontier gates to which he referred. The Tsung-li Yamen sent a telegram to T'êng-yüeh to say: "The frontier with Burma is about to be delimited; there are seven frontier gates; see that those gates are found." The Chinese at T'êng-yüeh knew nothing about them, but they sent out orders to all the headmen and said, "There are seven gates; you must put them in order; the Board of Punishments will see about it if you don't." Therefore, in the businesslike way of all Chinamen, and people under Chinese orders, they proceeded to go to the farthest point to the south and the south-west where they could go without getting into trouble with the hill tribesmen, and proceeded to build seven gates, which were afterwards pointed out to the Chinese Commissioners when they visited the place. Their position was duly noted, but the frontier which was eventually laid down went near none of those gates at all. Their only use was that they pointed out the limit to which the Chinese could extend their authority. The people along the frontier were mostly Kachins, who were really the same people as the Singphos. Their own name for themselves in fact was Chingpaw. The author had stated that the Singpho were not a martial people. They must have deteriorated from the main body of the race, because although a Kachin might not be called a warlike man, he could not at any rate be called an effeminate or a degenerate. Their chief occupation for many years was stealing other people's cattle, which they did with quite as much enthusiasm as the Johnsons and the Jardines did on the North British frontier. The Singpho were mixed up with a number of other people. Photographs had been shown of the Lissu, who, the author had led them to believe, were the only people who possessed crossbows, but that was by no means the case. There were quite a number of tribes a long way inside British territory who had crossbows. He remembered on one occasion he got a number of Muhsö to beat the jungle for a shooting party, but unfortunately very little game was obtained. In order to reward the beaters, and to amuse themselves, an archery meeting was got up with coins as prizes. The party, however, found that it was a great deal too expensive to put up rupees or eight-anna pieces to be shot at. Eventually two-anna pieces were put up, and quite often men at twenty-two paces were able to hit a two-anna piece every time. So that the Lissu, who were not British subjects, were not the only people who had crossbows on the borderland, and he hoped that would be a further inducement to the author to write a book about the North-East Frontier. The Kachins overlapped what might be called the North-East and by East Frontier, and especially they ran up beyond the point where the Burma frontier ended for the present. That frontier was determined at home. The signatories in the Foreign Office agreed that the frontier went up to a high conical peak. That sounded very satisfactory, but when the party got to the ground they found that the "high conical peak" was a noun of multitude. However, eventually they determined on a particular high conical peak, from which straight to the north there was a very satisfactory boundary from the map point of view and from the point of view of actual physical geography, namely, the watershed between the N'maikhah, which was the eastern branch of the Irawadi, and the Salwin. Unfortunately, the hills in that country constitute the worst kind of frontier, because the people who lived in the hills usually lived very near the top. The race which lived highest in the hills were called the Lihsaw, who might be connected with the Lissu, although Dr. Grierson said they were not. Their chief form of occupation was cutting down and burning jungle, which, from the point of view of science, was the very best form of agriculture. The Forest Officers, however, did not like it; the climatologists said it spoilt the rainfall, and in any case it did not suit a hill-top frontier. The sooner that frontier was marked down the better. Beyond the North-East and by East Frontier there was another frontier which might be called the North-East and by East, a point to the East, namely the Wa frontier. The Was were a little more troublesome even than the Kachins, for they made a habit of head-hunting. The trouble all along that frontier, not only with the Was, but with the Kachins, was due to the latest Opium Agreement. According to that Agreement, no opium could be sent from any part of British India into any province of China where opium was not grown. It was said that no poppy was now grown in Yün-nan, but the Wa had never grown anything else but poppies for centuries. For many hundred years before the Anti-Opium Society ever existed they sent tons of it into China, and would go on doing so now despite all conventions between this country and China, because they wanted salt. They did not want money; all they wanted was salt and rice with which to make spirits, and serious trouble might be experienced there. He must conclude abruptly. The Chinese frontier was very much like a lady's hat which was kept firm with a steel hatpin. The frontier would be fixed by driving railways through the frontier like a lady's hatpin through a hat.

Mr. Angus Hamilton said in the very interesting paper to which they had just listened with so much pleasure, Sir Thomas Holdich had referred

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to the Mishmi Mission. As the special correspondent of the London Central News Agency with the Abor Expedition, it was his privilege to witness the preparations for the departure of the Mission from Sadiya. Sir Thomas Holdich stated that the distance between Sadiya and Rima was, as the crow flew, about 100 miles. By road, of course, the distance was much more; in fact, from Sadiya, whence the expedition set out, to Rima, which was the real limit of Chinese authority on the Tibeto-Mishmi border, the road was at least 198 miles. It was very doubtful whether the Mission would proceed to Rima. Unfortunately, the Government ordered Mr. W. C. M. Dundas, the Political Chief of the Mission—and a man of unrivalled reputation as an authority upon the languages and tribes of the Assam border—not to advance beyond the places in the Lohit valley to which the Chinese had penetrated. These places—and they represented the limits of Chinese encroachment in the Lohit valley—were Menilkrai and Walong, and hitherto they had been regarded by the Mishmis as within the tribal line. The distance from Sadiya to Walong, the more easterly of the two places, was 165 miles, and it was somewhere between Menilkrai and Walong that the British Government had ordered Mr. Dundas to place a cairn, which should serve to indicate where the frontier between India and China begins. The exact spot to be honoured by this distinction, if the real limits of tribal territory were recognised, would be between Sama and Rima, and opposite the position where the Chinese had set up their standard. There were but very few villages in the course of the Lohit valley between Sadiya and Walong, and it was interesting to know that Mr. Dundas was proposing to establish a chain of posts, which would be placed at intervals of fifty miles along the valley, and could serve as the supply depots of the Mission. The first of these fifty-mile posts out of Sadiya was Temiemukh, where three months' provisions for the entire force were to be held in reserve. Kupa, where only two months' reserve stores were to be stocked, was the second post of this character, while the third was Mingszan, where six weeks' reserves were to be kept. Beyond Mingszan, ten miles away, stood Menilkrai—nothing but an oasis of sand and river-bed—over which, with calm and celestial impudence, flew the Dragon Flag, unguarded and alone. Five miles further came Walong, where a family of half-caste Tibetan traders occupied three dilapidated houses. Thirty-three miles further on was Rima, the road to it passing through a country that was bleak, deserted and uninviting, though not sufficiently uninviting to have repressed the curiosity of the Chinese, who, as had just been stated, had set up their flag at Menilkrai. From Sadiya to Temiemukh it was possible to go either by land or by water. The waterway met the land route at a place called Diphu, while a few miles further along at Sanpara the limit of navigation by boat was reached. The journey by river as far as Sanpara was one of considerable danger, for the stream was beset with rapids, over which canoes had to be dragged, while, in addition, there were rather bad whirlpools and many patches of quicksand. He (the speaker) was afraid he was unable to discuss the political aspects of this region, as one of the unwritten laws of the Society debarred all reference to politics. At the same time he was sure that all would understand how much importance attached to the outcome of the Mishmi Mission, and, personally, he hoped that they would not understand a process of reasoning which cut the cake in half when the whole cake could be taken away. By this he meant that the cairn to be put up by the Mishmi Mission at the orders of the British Government cut the tribal lands in half when all the chiefs of these lands were only too anxious to place the whole of them under British protection. It was difficult, perhaps, to state definitely the precise limits of the Mishmi country. The tribes themselves, however, had always considered that their lands ran as far as Sama, some little distance up the Rima valley, and they should be the best judges, particularly as the Chinese had never before been seen at Menilkrai, and had only appeared there because a patrol from Rima, when that ramshackle village was garrisoned the other day by Chinese troops, casually wandered into and along the Lohit valley. In the present unsurveyed state of the tribal lands it might be of value to count the divisions accepted by the people themselves. There were in the first place four tribal groups—the Midus or Chulikattas, the Bebejiyas or Mithuns, the Taius or Digarus, and the Mejus. As an indication of the Mishmi boundaries, perhaps he might say that the Chulikattas occupied both banks of the Dihang river, many of the larger and more affluent villages lying close to the Tibetan border, and were found also in the ranges north of Sadiya from the Sesseri River on the west to the Digaru River on the east; the Bebejiyas frequented the valleys of the Ithun and Ithi Rivers, holding the country to the north of the Sihi range and Saruba Peak and east of the Chulikattas, and bordered on the north by the ranges of southern Tibet, and on the east by the possessions of the Digarus. The Digarus lay to the east beyond the Digaru River, and the Mejus were further east again, towards the Lama valley, a sub-prefecture of Lhasa. In general, the Mishmi country was mountainous, greatly cut up by watercourses, and difficult of access. The mountain valleys were covered with dense jungle, and the crests of the ranges were hidden in snow. Trade was poor, and cultivation scanty. The tribesmen were of uncertain temperament and small in stature, though wiry, with strongly-marked Mongolian features, while, finally, the four great tribal divisions were split into numerous clans, in which the language, manners and customs, while varying slightly between the several groups, were altogether different from those prevailing among the Abor peoples.

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Lord Sanderson, G.C.B., K.C.M.G., in proposing a hearty vote of thanks to the author for his very interesting paper, said he had the greatest pleasure in doing so, because Sir Thomas Holdich was an old friend of his, and an officer to whom, when he (Lord Sanderson) was at the Foreign Office, they were greatly indebted on many occasions. Sir George Scott had referred to the Seven Gates on the Chinese frontier of Burma. He was one of those who had to carry on the negotiations at the Foreign Office in connection with the delimitation of that frontier. He did not think he was personally responsible for the choice of the conical peak to which reference had been made, but he recollected perfectly well the seven gates, and that the Chinese Minister said he must have them, although he could not say where they were. The sufferings of the British negotiators were very great in consequence.

Mr. H. Luttman-Johnson, in seconding the motion, said that he lived on the North-East Frontier for a great part of his life, and he was, therefore, able to confirm from his own personal experience the accuracy of all the statements contained in the author's excellent paper. He thought an extraordinary vote of thanks was due for a paper so good in matter and style. The author had done a great service in pointing out how very much Assam was connected with China and Tibet. When he used to go fishing up the Subansiri he heard stories of bodies of people being washed down in times of flood, and those people had been identified as Chinese and Tibetans. In his bungalow at Gauhati, swarms of Tibetans used to visit him, and he had known Chinese gentlemen pass through Dewangiri on their way to pilgrimage at the reputed scene of the death of Buddha. He used to pay the Tibetans their annual posa (tribute) at Udalguri Fair. He remembered a trader from Lhasa who came to visit him comparing his bungalow with those he had seen at Darjeeling. The Daflas had often described to him the cities of the Upper Subansiri. His wife's wedding ring was made of Tibetan gold.

The resolution of thanks was carried, and Sir Thomas Holdich having briefly acknowledged the compliment, the meeting terminated.

Mr. Archibald Rose, C.I.E., late British Consul on the Burma-China frontier, writes:—"It was with great regret that I left to-day before the discussion on Sir Thomas Holdich's most interesting paper, for I felt that our imagination had been thoroughly stimulated in regard to the frontier and the neighbour beyond those jungle-covered hills. In every frontier question the neighbour counts for so much, and on this north-east borderland the interest and influence of China is accentuated by the fact of the intervening tribal belt. I have brought back from the far side of the border a realisation of the Chinese genius in the *rôle* of frontiersmen. They have shown an unmistakable imperial gift in Central Asia for the last 2,000 years, whilst their recent activity in Tibet, and their peaceful penetration into the tribal country, seems to show no decrease in vitality. For many years the unadministered tribes have formed a definite buffer between the two great empires. The whole history of Central Asia, however, leads one to the conviction that political and imperial frontiers are inevitable developments, and that the prosperity and well-being of settled communities can only be assured when the scattered tribes have been brought to a realisation of their responsibility both to their tribal neighbours and to the great Powers within whose zone they have their homes. This fact has been realised by China; she has set herself, with a striking tenacity of purpose, to the administration and often to the absorption of her tribes, devoting one of her most brilliant statesmen to the task. It has not been difficult, for Chinese prestige stands high in the border country. It is a prestige gained by long centuries of quiet work and of little expeditions, till the tribesmen on the Chinese side look to the 'father and mother official' as the embodiment of all wealth and learning and power. As a result the sedan-chair of a mandarin and a handful of soldiers are generally sufficient to quell any tribal disturbance, though China does not hesitate to undertake new and difficult campaigns when they become necessary, as in the more lawless Shan States on the south of the Burma-China border. Such a frontier prestige is an enormous asset to China as an empire, and it is not without significance that, even in the midst of the present chaos in China, an early manifesto of the revolutionary leaders pointed out the vital importance of strengthening the frontier administration in this region. It is a factor, too, that can well be appreciated by us, for like the Chinese we have an empire with long land frontiers, and we actually march together for some 3,000 miles on the Chinese-Indian border. My experience in the Chinese border country convinces me that Great Britain and China will find mutual difficulties and common interests in dealing with the problem of the North-East Frontier; and that the best interests of both empires will be served by a policy of friendly co-operation, with a definite political frontier and a belt of tribesmen who have been brought to a realisation of their neighbourly responsibilities.

ELEVENTH ORDINARY MEETING.

Wednesday, February 21st, 1912; Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bevington, Alexander, Silverwood, Pyrford, near Woking, Surrey.

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Cadogan, Lieutenant Francis Charles, R.N., H.M.S. "Prince of Wales," c/o General Post Office, E.C.

Hussain, Moulvi Ahmed, C.S.I., M.A., B.L., Chief Secretary to H.H. the Nizam's Government, Hyderabad, Deccan, India.

Reinhold, Captain Carl Henry, I.M.S., F.R.C.S.E., 58th Rifles, F.F., Quetta, Baluchistan, India.

Scott, Charles, Rosedale, Bolivar County, Mississippi, U.S.A.

Singh, Baba Mihan, Small Cause Court, Amritsar, India.

The following candidates were balloted for and duly elected members of the Society:—

Bieber, Miss Caroline Frances, F.Z.S., 25, Wetherby-gardens, South Kensington, S.W.

Heaven, Francis Gyde, 132, Gresham House, Old Broad-street, E.C.

Lee, Ivy L., 24, Throgmorton-street, E.C.

Randall, Wilfrid Levison, F.S.A.M., Port House, Brimscombe, Gloucestershire.

Wallis-Tayler, Alexander James, Assoc.M.Inst.C.E., "Esquimalt," Robin Hood-lane, Sutton, Surrey.

The paper read was—

THE BRITISH SILK INDUSTRY: ITS DEVELOPMENT SINCE 1903.

By Frank Warner.

On December 15th, 1903, I had the honour of reading a paper on the British Silk Industry before the Royal Society of Arts, and, in the course of my remarks, I said: "As to the future of the industry, it is, in existing circumstances, impossible to speak hopefully, although we shall, in all probability, retain what we now hold. Forty-three years' exposure to the killing competition of the world's lowest-priced labour has removed all or nearly all that was assailable; that which remains exists by virtue of its undeniable merit in technical skill, genuineness of quality, and excellence of design and colour."

More than eight years have passed since that opinion was expressed on the probable future of the industry, and I am proud to be able to say here to-night that we not only retain nearly all we then possessed, but, gaining confidence instinctively from a well-secured position, we have advanced economically, technically and artistically in the manufacture of silken materials. The tide of destruction and decay has been stemmed, and we are able to look to the future with an increased measure of hopefulness.

To claim more would be suggestive of exaggeration or, at least, of undue optimism, and, whilst hope maketh for endeavour, over-confidence, or even satisfaction, with our present position, would hasten back that condition of despondency and failure which was general in the industry a few years ago.

We must recognise the fact that the trade conditions under which our home industry is carried on are rather worse, certainly no better than they were; for, in addition to the insecurity and uncertainty of the demand for home-made silks which naturally arises in a market open to the free entry of goods from every country in the world, recent legislation, to which I will refer later on, has added financial burdens, the full effect of which is bound to tell heavily on some branches of the industry in the near future.

Unlike the silk manufacture of foreign countries, where the industry is centred in one or two towns — for instance, Lyons in France, Crefield, Elberfeld and Langenberg in Germany, Basle and Zurich in Switzerland, Milan and Como in Italy, Paterson and South Manchester in the United States—that of the United Kingdom is so scattered that a definite and easily-obtained conclusion of its position is impossible.

The following reports from several towns, which are recognised by those interested in home manufacture as silk centres, will help us to arrive at a rough estimate of the progress or decline of the industry since 1903:—

From Macclesfield comes very welcome news. In this old and still leading centre of the industry there has been a great improvement in trade since 1903, and, although there has not been a considerable increase in the number of workers, those who are in the industry are more steadily employed, and in some branches their rate of earnings has risen by 10 per cent. to 15 per cent. During this period, several firms have made important extensions, but otherwise there is little to record in the way of change. There are six firms of silk throwsters in the town, the same number of embroiderers, five firms classified as "fancy trimmers," and seventeen firms who manufacture men's silk mufflers, handkerchiefs, and general neckwear, dress and knitted goods and shirtings. The increased prosperity of Macclesfield is due to the greater demand for richer qualities of cloth, to the introduction of new classes of manufacture in the middle and

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lower-grade goods, and to a more general enterprise amongst manufacturers in regard to catering for changes.

This splendid move on the part of the Macclesfield manufacturers accords with my knowledge of their ability and determination to succeed in spite of dispiriting antecedents and of a home market more than ever flooded with cheap shoddy foreign goods. It confirms, moreover, the opinion I expressed in the last paper I read here, viz., "that where manufacturers show originality and enterprise, and adopt the most modern and economical methods of production, they have mostly succeeded in finding a market for their goods at remunerative prices."

Macclesfield, however, possesses something even more valuable than a high development of commercial virtue; it has in its splendid art and technical schools, which have already proved of inestimable value to the manufacturers, a great creative and inspiring force, which, if taken full advantage of by the rising generation, will provide still surer foundations for future prosperity.

BRADFORD is another silk centre, which possesses to an even greater degree ideal and perfectly-equipped schools, where art, in its relation to design, and science, as applied to the textile industries, are studied in conjunction by those young people who, in the near future, will have the control and management of our silk factories, and through whose imagination will come the productions destined to meet, in the world's competition, those created in other countries by a system of training every bit as developed and advanced as our own.

Unlike other silk centres, Bradford is not an old seat of the industry, but it is to-day a very important and prosperous one. Its position relative to Macclesfield as the premier silk centre is not one that we need consider, nor is it in fact determinable, its use of silk being so intermingled with other yarns, that even if a separate inquiry were addressed to each firm using silk, I doubt if a really accurate return would be obtained of the number of people actually working on it.

From an inquiry made through the Bradford Chamber of Commerce, I learn that there has been no increase in the local silk trade since 1903; that the thirteen firms using silk are the same as at that period, and that although no more persons are estimated as being employed in the industry, their wages have advanced by about 10 per cent., from which it is fair to assume that times have been more prosperous.

Apart from the general silk trade of Bradford, special reference should be made to the great and famous firm of Lister and Co., Ltd., which now employs about 7,000 people, an increase of 2,000 since 1903.

Of this enormous number, 1,000 are employed in their factories at Nuneaton, 500 at Addingham, and the remainder at Manningham, near Bradford. Messrs. Lister are spinners of spun and sewing silks, as well as manufacturers; the goods for which they are most noted being pile fabrics, such as velvet, plushes, and imitations of seal and other furs. They also make all sorts of dress goods and furnishing fabrics.

Apart from Bradford, there is in the county of Yorkshire the great industry of silk spinning —that is, the cleaning, combing and spinning of a thread known as spun silk from silk waste.

Spun silk, although essentially a highly-manufactured article, is the raw material for other branches of the industry, being used in almost every kind of silk fabric, particularly in hosiery and lace. English-spun yarns, possessing qualities superior to similar yarns of foreign manufacture, are in great demand, both in this country and abroad. This branch of our British silk industry is a large and prosperous one. There are twenty-two firms engaged in it, fourteen of whom are in Yorkshire, mostly concentrated in Brighouse, the others in the adjacent northern counties of Lancashire and Cheshire, and Nottingham. It absorbs 10,000 workpeople, nearly one-third of the total number of silk workers in this country. Their rate of wages has scarcely changed, except at Brighouse, where there has been a slight rise in the wages of female workers of about 10 per cent.

During the last eight years silk spinners have been well employed, latterly on tussah spun, without any marked increase in the output of yarns, owing to mill extension having been very slight.

The supply of waste silk since 1903 has been steadily falling short of the demand, and since 1906 prices in all classes have been consistently higher. Each new season has opened at a higher initial price, and with shipments offered further ahead. This has indicated an absence of stock carried over from season to season, and a natural inference to be drawn is that the world is consuming more spun silk than

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before. This must be so, for, in addition to the productions of England, America, and the Continent, the Japanese have been laying down plants of English and foreign machinery, and are now exporting their products to this country.

An examination of their yarns shows, however, that they are not so well managed as are the European product, and in spite of their cheap labour the Western spinner easily holds his own. The Japanese spinner has, however, made rapid progress in improving his yarn, and should it be maintained at the same rate, he will within a short time become a formidable competitor.

Historically, it is of interest to note that during the twenty years between 1883 and 1902 no fewer than twenty-five firms went out of existence through various causes—chiefly failure. The cause of failure was in every case clearly understood, for, in addition to mismanagement and unsound trading, a view of their machinery, at the subsequent auction, caused one to wonder how they had existed so long. Now that these bad businesses are weeded out, a very different spirit animates the existing managements, and this is manifested by a desire to emulate the example of the larger textile industries of the country, and to learn the important lessons of economy and specialisation of production.

To mention the town of LEEK is to bring vividly to our memories the name of that kindly, able, and ever optimistic champion of the British silk industry, the late Sir Thomas Wardle, for twenty-one years President of the Silk Association of Great Britain and Ireland, whose invaluable services in the cause of sericulture generally, and of the home silk trade in particular, are historical.

Trade in Leek during recent years has been prosperous and increasing, but if due allowance be made for the more extensive use of other yarns, such as mercerised cotton and artificial silk—owing to their more perfect preparation—it is doubtful if any advance can be claimed in the manipulation and consumption of real silk. Partly from the same cause, and also because of the vagaries of fashion, the old Leek silk trade is more or less on the decline; but the industry of spinning spun-silk yarns is doing well. Although three firms have closed down during the last eight years, as many new firms have been established, and there are in Leek to-day over thirty firms engaged in the manufacture of such articles as sewing, crewel and embroidery silks, braids, trimmings, bindings, and similar webs; and, in addition, the well-known silk-dyeing firms of Messrs. Sir Thomas and A. H. Wardle and Messrs. Joshua Wardle and Sons, both of which excel in this important branch of the industry. Since 1903 not only has the number of workpeople increased, but there has been a rise in wages amounting to about 15 per cent.

The textile history of COVENTRY since 1903 is remarkable for the foundation of the large artificial silk-spinning industry by Messrs. Courtauld and Co., and although artificial silk is not silk, it is in every sense satisfactory that so important and lucrative a branch of yarn production, which until recently was entirely monopolised by the foreigner, should be successfully established in this country. Artificial silk is now produced in enormous quantities, no less than 13,225,000 lbs. being estimated as the world's production in 1911, and its use in the manufacture of many articles, such as braids, trimmings, lace, net, and cheap dress fabrics, is so universal that it is in every sense desirable that its manufacture in this country should be greatly extended. Putting a very natural prejudice aside, we must recognise that as an article of commerce it has come to stay, and it is better that we should make it than that we should leave it to the foreigner.

Apart from this development, Coventry has no progress to record. Employment has been fairly regular, resulting partly from the steady decrease through death in the number of "outdoor" weavers, and the consequent transfer of looms to factories, which necessarily provide more regular work than could be got in individual workshops.

The total number of hands employed in weaving probably remains much as it was eight years ago. The number of firms engaged in the industry is also unaltered, four new firms having replaced four that have ceased to exist. There are three firms of silk dyers in the town, and twenty firms who carry on the making of small wares, such as hatbands, belts, ties, coach-lace, book-markers, and other narrow webs, and also ribbons, for which Coventry was once so famous.

With regard to NOTTINGHAM, the trade is of such a composite character as to render analysis almost impossible.

If we take its principal industries of lace, gloves, and hosiery, it will be safe to say that the silk section of these has not increased

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of recent years, although the growing demand for silk hosiery has provided sufficient employment to compensate for the falling-off in the silk, lace, and glove departments. On the whole, therefore, we may regard the trade of Nottingham as having held its own in the past, with the prospect, should fashion favour the other branches of its industry, of prosperous development.

The EASTERN COUNTIES of Norfolk, Suffolk, and Essex, are not only celebrated as old centres of the industry, but are becoming even better known for their up-to-date productions; for it is from Norwich, Yarmouth, Braintree, Bocking, and Halstead, that those wonderfully beautiful, diaphanous fabrics come, such as crêpe-de-chine, crêpoline and ninon, as well as the richest and most elaborate brocades and velvets for dress and decorative purposes; the latter in particular come from Braintree and Sudbury. The Norwich industry is a very ancient one, the bulk of its manufacture is mourning crape, but in addition to this, and the light dress goods already mentioned, poplins and silk mufflers are also made, the latter for men's wear being the richest and most beautiful I have ever seen. At Great Yarmouth, Messrs. Grout and Co., Ltd., are the sole manufacturers; their business of recent years has increased by almost 25 per cent., with a consequent increase in the number of their employees, and of 10 per cent. in the rate of wages. The increasing prosperity of this old firm is entirely due to their enterprise in widening the scope of goods manufactured, and to their appreciation of the value of international exhibitions, of which their exhibit at Brussels was a proof.

In Suffolk, the only town of importance from the point of view of silk manufacture is Sudbury, where it is gratifying to know that there has been a distinct increase of trade since 1903, more persons being employed in the factories, although cottage weaving, as elsewhere, is declining.

Sudbury is noted for its manufacture of umbrella and sunshade silks, and hand-loom velvets; but certain specialities for the drapery and hosiery trades are also made by Messrs. Stephen Walters and Sons, Ltd., who are the largest employers of labour, and some high-class decorative and furnishing silks by the recently established Gainsborough Silk Weaving Company.

In Essex, at Braintree, Bocking and Halstead, are the extensive factories of Messrs. Samuel Courtauld and Co., Ltd., who have a world-wide reputation for their enterprise and ability in silk manipulation. They manufacture, in addition to their staple article, crape, large quantities of light and dainty dress materials, such as crêpe-de-chine, crepon and ninon.

The other firm manufacturing at Braintree is the one established by my father in 1870, and now carried on by my brother and myself, and we are doing our best to maintain the high reputation which his efforts succeeded in gaining for the business.

In the last paper I read here I mentioned the work my firm carried out for the Coronation of King Edward VII., and it is with grateful satisfaction that I here place on record the fact that we were entrusted with the making of the materials for the Coronation robes of Their Majesties King George V. and Queen Mary; and also of the brocades for Her Majesty's dresses worn on State occasions, together with many other fabrics used in connection with the wonderful and impressive State ceremonies crowded into that memorable Coronation week.

The greatest surprise I have met with, in the course of my inquiries, is the report of the present condition of the Scottish silk industry. I mean it as a compliment when I say that even where everyone else fails, a Scotchman will still manage somehow to get a living. The silk industry under modern conditions affords him an almost exceptional opportunity for the display of his qualities. Is the industry in so bad a way that even he has failed to make it a success, or has he, with his usual acumen, found something more responsive to his labour and the risk of capital, and left silk, with its uncertain yield of profit, to those who, fascinated with the beauty of the material upon which they are working, would rather die starving than give it up?

I absolutely decline to answer the question. One thing, however, is certain, and that is, Scotland does not stand where she did. Hand-loom weaving in the old districts is almost extinct, power-loom weaving is on the wane, and the silk industry generally, instead of being progressive, is slack and declining.

There are many firms using silk which are not classified as silk manufacturers. In cheap tapestries, casement cloths, and dress goods, silk is being used, and very excellent and artistic are the materials which are made in Scotland to-day; in fact, in certain classes of mixed

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goods, none better in construction, colour, or fastness to light, are being made in all the world, and I half suspect that beneath all this external pessimism of the Scottish manufacturer there is a satisfactory but unrevealed measure of prosperity.

This survey of silk localities would be incomplete without special reference to the Irish poplin industry which is concentrated in Dublin. Five firms share in its manufacture, the largest of which is that of Messrs. Richard Atkinson and Co. This beautiful dress and tie fabric, of pure silk warp and fine wool weft, is kept at a high standard of excellence by the Irish manufacturers, and their virtue is rewarded by having 193 looms running to-day in place of 117 in 1903.

This revival of the Irish poplin industry is also a standing tribute to the efficiency of the Merchandise Marks Act, 1891, which on several occasions has been the means of crushing daring misrepresentation, carried to the extent of labelling cheap all-cotton strips, at 2*d*. each, as Irish poplin ties. Without the beneficent guardianship of this Act, it is practically certain that this old and beautiful industry would have been overwhelmed in an unrestricted flood of spurious imitations.

In addition to the localities I have already mentioned, the industry of silk in some form or another is carried on at Patricroft, near Manchester, at Leigh in Lancashire, at Derby, St. Albans, Taunton, Merton Abbey, where Messrs. Morris and Co. make the beautiful fabrics designed by the late William Morris, one of the most famous of English art craftsmen; at Haslemere, Letchworth, Windermere; at Tiverton, where Messrs. John Heathcoat and Co. employ 1,600 people in the manufacture of silk net, and last of all in London, where silk weaving still exists in the East End districts commonly known as Spitalfields.

In the actual parish of Spitalfields, the sound of the shuttle has long ceased to be heard—it has gone completely and for ever; but in the neighbouring district of Bethnal Green and Old Ford there are 130 weavers, of whom 76 are men and 54 are women, engaged by various firms in the manufacture of silk ties, scarves, wraps and handkerchiefs. These weavers are mostly aged people, and as there are practically no learners, there is nothing left but the remnants of a once great industry. Other occupations, such as silk winding, harness making, etc., give employment to about 70 people, raising the total of Spitalfields silk workers to the number of 200.

In addition to the weaving industry, there are, in various parts of London, many firms engaged in the manufacture of upholsterers' trimmings in which silk is used, but as other yarns enter into the composition of these articles to a much larger extent, the workers in this trade can hardly be classed under the heading of silk. An exception, however, is the factory of Messrs. Pearsall and Co., in the City of London, where 120 people are employed in winding and other work connected with this firm's well-known unfadable sewing and embroidery silks. Messrs. Pearsall have a much larger factory at Taunton, where 500 people are employed in working silk in other stages of its manufacture.

In connection with London I ought to mention the manufacture of men's silk hats, where the best in the world are made in the neighbourhood of Blackfriars and Bermondsey; the silk plush and the galloons, or braid, come from Lyons, the black dye of Lyons being considered best on account of its more intense blackness.

I am afraid I must now weary you with some statistics, taken from the Board of Trade Returns, which I have compiled, with the object of comparing, A, our present position with that existing before the year 1860, when the duties of foreign goods were removed, and B, our trading in raw and manufactured silk since 1903 with the eight previous years.

TABLE I.

The Number of Persons Employed in the Silk Industry in the United Kingdom decennially from 1851 to 1901.

Year.	Males.	Females.	Total.
1851 . . .	53,936	76,787	130,723
1861 . . .	43,732	72,588	116,320
1871 . . .	29,225	53,738	82,963
1881 . . .	22,205	42,630	64,835
1891 . . .	19,090	32,937	52,027
1901 . . .	11,058	26,422	37,480

The figures for 1911 are, unfortunately, not yet available, but they will probably show some reduction on the returns for the year 1901.

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TABLE II.

Imports of Raw, Thrown, and Waste Silk, decennially from 1851 to 1911.

Year.	Raw.	Thrown and Spun.	Waste.
	lbs.	lbs.	cwts.
1851 . . .	4,608,336	412,636	14,073
1861 . . .	8,710,681	124,574	29,627
1871 . . .	8,253,335	177,386	38,984
1881 . . .	2,904,580	131,836	54,119
1891 . . .	2,434,609	581,867	77,556
1901 . . .	1,332,480	624,859	48,162
1911 . . .	1,238,775	736,630	81,261

TABLE III.

Imports of Silk Manufactures, decennially from 1851 to 1911.

Year.	Values.
	£
1851	Not obtainable.
1861	5,906,029
1871	8,397,938
1881	11,727,397
1891	11,179,588
1901	13,030,321
1911	12,765,497

TABLE IV.

Exports of Manufactured Silk Goods, decennially from 1851-1901.

Year.	Values.
	£
1851	Not obtainable.
1861	1,395,582
1871	2,053,086
1881	2,564,730
1891	1,744,645
1901	1,429,381
1911	1,851,136

The figures I have placed before you are significant and full of meaning; they provide to some minds the first elements of fiscal conviction, to others the essentials of rebutting argument, and to all who know very little or nothing of the subject an ever-ready and inexhaustible supply of material for controversy of an amateur or after-dinner kind.

That these figures have a fiscal bearing is certain, but facts concerning them, not commonly known outside trade circles, must be considered, and these I will endeavour to explain, so that the whole position may be revealed, and a fair and proper verdict arrived at. Let us first of all consider the census returns of the number of people employed in the industry, which in 1851 was 130,723, and in 1901, the latest returns available, 37,480. These figures show a falling off of 93,243 persons, equal to about 72 per cent.

In the meantime, the population of this country has increased from 27,000,000 in 1851 to 45,000,000 in 1911; and we are told that, owing to the blessings of Free Trade, the affluence of the middle and lower classes of the people is such that they enjoy comforts and luxuries unknown to their forbears, who were doomed to exist under those gloomy conditions of Protection which our insular prejudice attributes to other countries to-day. Silk may surely be considered as one of those luxuries, and therefore, at first sight, it appears not unreasonable to expect that the number of our silk workers would have nearly doubled rather than decreased.

Instead of the numbers increasing, or even being maintained, there has been this enormous falling-off. Much of it is, of course, attributable to our system of importing free of duty foreign goods which compete with those of domestic production, but some is due to the conditions of manufacture and consumption, which have undergone a remarkable change since 1851. Let us take a typical cottage weaver of those days. The man and his wife and probably two children, aged sixteen and fourteen, would each have a loom; whilst two younger children of the tender age of twelve and ten years would be engaged in "picking the porry"—that is, clearing the warp of rough ends, and winding the quills or pipes for the shuttle. All these six people would be numbered as engaged in the silk industry. Under modern factory conditions, the man would probably be a loom-tackler, the wife a weaver attending two power-looms, the child of sixteen employed as a silk-winder, and the other three children at school—the output of silk goods of the three workers equalling, or possibly exceeding, in quantity that of the entire family under the old dispensation. Fashion, again, has wrought a great change; in 1851 a woman's skirt fitted over a wide-spreading crinoline,

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consumed four times the amount of material now required for the modern hobble-skirt; whilst the large silk waist sash and broad silk bonnet ribbons no longer exist, and even the rustling silk petticoat, so indispensable a few years ago, has gone.

In the meantime, the composition of silk goods has completely changed; mourning crape is out of fashion; the old-fashioned rich brocades, duchesse satins, and gros grains have given place to light gossamer materials which, often mixed with fine cotton or wool, consume but little silk in their manufacture. In men's wear, again, the stock of fifty years ago would make at least half a dozen modern ties, silk hats have mostly gone, silk waistcoats have disappeared even more completely, whilst silk linings to coats have been largely replaced by mercerised cotton fabrics. The utilisation of wood-pulp yarn, usually known as "artificial silk," of linen, wool, mohair, and mercerised cotton, all of which have undergone remarkable development of recent years, in the manufacture of goods having a silk-like appearance is enormous; and although it has enabled many articles to create a new market, it has been the means of displacing silk to a considerable extent. In this battle royal for supremacy between the different textile yarns, it cannot be said that the champions of silk have adopted a wise policy. They have, in many cases, either drugged the article or forsaken it altogether, but in this deception or desertion the British manufacturer has taken but little part. It is a fact of which we may well be proud, and although our industry to-day is small it is genuine, and in its rugged honesty lies the secret of its present comparative recovery and its future prosperity. There is still a place in the world for genuine pure silks, and although the demand for them may be limited, it is in their production that this country has the opportunity of making a great reputation, since foreign nations are sacrificing theirs in feverish efforts to get trade, regardless of the ruin which the degradation of silk as an article of use and wear must suffer as a result of excessive chemical adulteration.

It is not my intention to dwell at any length on the fiscal aspect of the question; it has been dealt with so fully of recent years by able speakers and writers from both the Free Trade and Protectionist standpoints, that nothing I can add would be either original or instructive. I will therefore confine my remarks to a brief summary of what I believe was the condition of the industry in the period 1850 to 1860, and what I know to be its condition to-day.

In the former period, with a duty of 15 per cent. on imported foreign goods, there was a large silk industry in this country; fortunes were often made by those engaged in its various branches, whether merchants, dyers, or manufacturers, although fortunes were sometimes lost. The trade was progressive, both with regard to the number of people employed and the amount of raw silk imported to be worked up into manufactured goods. New firms were constantly being started, and there is evidence that steam-power both for the working of looms and other silk machinery was rapidly being adopted in place of hand labour.

The goods produced showed much ingenuity and mechanical excellence; their purity and therefore their durability were beyond reproach, and for these reasons I believe the day is approaching, if it has not already come, when old English silks will be more highly prized than those of either France or Italy, particularly as those from the latter country are apparently inexhaustible, and although old in appearance are rarely so in fact. In design and colour the feature of British silks of those days was essentially its "Britishness," or what we now more usually term "early or mid-Victorian." They lacked the daintiness of the French silks, which then, as now, were preferred by the British public, particularly for dress purposes. Their heaviness in design and sadness in colour were, however, but the natural expression reflected in material of the grey and gloomy surroundings in which the manufacturers lived. Nothing existed to counteract the monotony of their environment, and although there was a school of design in Spitalfields, there were no art schools or other sources of art influence and education such as we have to-day. With all their shortcomings, these old British silks will always remain as a standard of true British merit, viz., sound workmanship, pure material, excellent value, and unbiassed to the public eye by a showiness meant not only for prettiness, but as a cover for the absence of sounder and truer qualities.

Move on the calendar fifty years, and let us review our position now. To-day we have a small silk industry struggling on in the same localities where once it was affluent. In places it appears weary in effort and jaded in look. As it passes, no new life springs up to replace the old. Elsewhere, although there is no appearance of change, there is an undercurrent of energy; businesses thrive and prosper, although there is but little change in their number; one rarely hears of new firms starting except to

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gather up the remains of some old-established business. It is not an industry which attracts the public in any way; no violent speculation and consequent appalling failures now disturb its history. Those who are engaged in it remain in it, without fear of disturbance from outsiders. It is, on the whole, financially sound, and in many cases yields a reasonable profit on capital invested.

The productions of the industry retain the genuine quality which distinguished those of fifty years ago, but it is marvellous to see the advance in their attractiveness, due to novelty of make, delicacy of colour, and meritorious design. To sum the matter up, where once we had a large industry, weak in many of its most important elements, we now have a strong one, strong in almost every desirable virtue, and we may, therefore, face the future confident that even if our fiscal conditions remain as they are, we shall at least retain our position, although we may do no more.

The silk industry of this country, so often described as a dying one, is to-day living and flourishing.

The object of my paper is not so much to go over the old ground so often surveyed as to consider the position of the industry since 1903, in the December of which year I read my last paper on the subject. We are, in my opinion, better employed in the consideration of recent rather than of remote periods of its history, and I have therefore prepared some statistical tables showing the progress in 1904 to 1911 inclusive, compared with the previous eight years, 1896 to 1903.

TABLE V.

IMPORTS OF SILK MANUFACTURES.

1896 to 1903.	1904 to 1911.
£	£
16,698,872	12,793,402
16,912,048	12,466,211
16,633,220	12,782,506
16,108,596	12,586,405
14,281,102	11,622,229
13,030,321	11,930,043
13,416,400	12,651,479
12,663,771	12,765,497
£119,744,330	£99,597,772

TABLE VI.

IMPORTS OF RAW, THROWN AND WASTE SILK.

1896 to 1903.	1904 to 1911.
£	£
2,039,958	2,036,971
1,874,624	1,928,091
2,196,665	1,955,161
2,317,452	2,255,505
2,046,194	1,884,559
1,736,080	1,770,347
1,884,663	1,881,146
1,784,242	2,146,195
£15,879,878	£15,857,975

TABLE VII.

EXPORTS OF MANUFACTURED SILK GOODS.

1896 to 1903.	1904 to 1911.
£	£
1,117,436	1,554,554
1,045,991	1,693,314
1,222,437	1,858,634
1,509,139	2,009,613
1,637,915	1,344,537
1,429,381	1,478,687
1,393,314	1,767,034
1,436,734	1,851,136
£10,792,347	£13,557,509

Based on values only, these tables reveal a rather striking result. Comparing the two periods of eight years already mentioned, the raw material imported, to which is added thrown and spun silk, is almost identical in value in each, but in manufactured goods we have imported £20,146,558 worth less since 1903 than we did in the eight previous years, whilst our exports of manufactured goods have increased by £2,765,162. Adding the amount in value of decreased imports of silk goods to the amount of the increased exports, we have nearly £23,000,000 to account for, and there can be, as far as I can see, only two directions in which it is possible to

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look for an explanation—viz., either that there has been a great falling-off in the home consumption of silk goods, or a remarkable increase in the value of home productions. The latter can hardly be possible, since our imports of raw materials have not increased in value, therefore the former cause is unfortunately in the main the principal one, although we are at least justified in attributing a small percentage of it to the greater vitality of our industry—a vitality which is entirely due to healthier principles of manufacture, to economy, which includes up-to-date mechanical equipment, and to the application of either improved design or colour to woven materials.

Such, then, is the improvement in the industry which has been gained by sheer pluck and hard fighting over ground thickly set with obstacles and affording no cover. Can it maintain its position in the coming years in view of the ever-increasing burdens of taxation? I think it may; but its progress will certainly be severely handicapped in many directions. The National Insurance Act, the principle of which appeals strongly to all that is good and kind in human nature, is so adjusted that in its working it will inflict grievous injury on many deserving firms. It would be improper for me to-night to make an attack upon the Act, but I may at least be permitted to point out where it will press hardly upon the silk industry. Silk manufacture, to compete with foreign production, must be carried on in districts where there is a plentiful supply of cheap female labour. Quite two-thirds of those furnishing this labour are under thirty years of age. Amongst them there is always a large proportion of learners. The lower the wage the higher the amount of tax paid by the employer. In some factories it is estimated that the cost under the Act will amount to nearly £1 per female per annum, if extra expense for clerical work is included. Therefore, an employer of 1,000 females will have to pay from £800 to £1,000 a year tax, whether he is making a profit or not. In addition, there will be, as a result of the Act, greater cost for many things, such as buildings, repairs, gas, coal, electricity, local rates, etc. Many businesses go on for years merely making ends meet, the employees alone benefiting. Under the Act such businesses will be ruined.

The outlook in the direction of railway rates is discouraging. For many years the industry has agitated, through the Silk Association, for lower rates for silk, the rates being double those charged on Continental railways.

Instead of a reduction there is only too much reason to fear that, as a result of the recent agitation amongst railway workers, the charges will be considerably increased, and that the iniquitous Carriers' Act, which exempts the railway companies from any liability on parcels of silk of greater value than £10, will continue in force.

This question affects not only those who are engaged in the manufacture of silk, but the much larger numbers who trade in it; and I would recommend that every responsible person who handles silk in a mercantile capacity should join the Silk Association and strengthen it in its efforts in resisting the attempt which is sure to be made in the near future to add further to the present unfair and excessive charges on the carriage of silk. The industry is not so happily placed that it can afford internal conditions of an oppressive nature. Externally, scarcely a month —certainly not a year—passes without seeing additional handicaps placed on our export trade, either in the nature of increased tariffs or amendments of Customs regulations of an onerous nature, all of which we meet with the most determined opposition of a moral or persuasive kind, which occasionally results in some mitigation or postponement. We have, however, no really effective check to place upon these endeavours of foreign countries to shut out our export trade with them. Our export of silk goods, although important to some firms, is small in comparison with our home trade, and it is, therefore, vital that we should first of all consider the home conditions. If we do, we find at once a most unsatisfactory condition of things arising from a widely-spread misuse of the term "silk," which is applied indiscriminately to goods containing but little silk, and in many instances to others having not a particle of silk in their composition. The unfairness to the silk industry and the deception to the uninitiated public, who readily buy as silk anything that is described as and looks like silk, call aloud for some definite and strong action which will rid our commercial character, sometimes held up to the world as an example of all that is high-minded and reliable, of the discredit of perpetrating as mean a fraud as it is possible to imagine. Silk, apart from its beauty and lustre, has other and possibly more valuable properties—viz., remarkable elasticity, strength and durability; as an article of clothing it is light in weight, delightful to the touch, non-flammable, and possesses disease-resisting properties. Its fair fame was well known and highly prized by past generations;

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to-day it is humiliated by the rapidly increasing use of goods made from yarns of vegetable origin, either cotton waste or wood-pulp, which are sold by unscrupulous salespeople, sometimes labelled and described as silk, at others as silk with some slight qualifications, but with the employment of the word silk in such a way as to beguile an unsophisticated public into the idea that silk at any rate forms the basis of the article they are purchasing, whereas it does not enter into its composition in the slightest degree. These vegetable fabrics are strikingly lucent in appearance, dull and heavy to the touch, lack the strength and wearing properties of silk, and are as inflammable as cotton. Cheap in price, they command a ready sale, but purchased as silk they are ruining the old popular faith in that material. Yarn of vegetable origin is now so extensively used in manufacture that there are but few dress fabrics quite free from it—some, such as braids and trimmings, tulle, net, and veilings, sewing and embroidery silks, are entirely artificial. In connection with all this adulteration and misrepresentation, the question has arisen as to what fabrics may be called "silk" and at what point the line is to be drawn at which they may not be so described. With a view to meeting this difficulty, I have compiled the following memorandum, which may serve some useful purpose, although it is but rudimentary.

SILK FABRICS.

There is apparently no written authority which prescribes that silk goods, so called, must or should consist of nothing but pure silk. There is equally no written authority which allows that goods may be termed or called "silk" which contain either no silk at all or silk in a limited or minor degree. The customs or usages of trade provide, therefore, the only standard by which goods called silk can be fairly understood to rank as silk, whether consisting of pure silk only or of silk mixed with another material, such as cotton, wool, linen, wood-pulp yarn (commonly termed "artificial silk"), or of silk charged with an adulterant in the process of dyeing.

In order to define these trade customs or usages, it is necessary to classify the goods under the following headings, viz., "Pure Silk Goods," "All Silk Goods," "Silk Goods."

"Pure Silk Goods" must only be called so when unmixed with other yarns, or when consisting of absolutely nothing but pure silk—that is, silk free from adulteration either by tannic acid, sugar, tin-salt, or any other kind of added constituent; but the silk may be of any kind, either cultivated or wild, no matter what may be its country of origin; or the fabric may consist of spun silk, which is a thread spun from silk waste.

"All Silk Goods" must contain no other textile yarn, such as cotton, linen, wool, ramie, or artificial silk; but fabrics called "all silk" are commonly adulterated by means of weighted dyes, both in warp and weft. The limit to which this adulteration is commonly carried in colours is a 24oz. return for warp and a 32oz. return for weft, known in the trade as a weighting of 50 per cent. and 100 per cent. respectively, the percentage being based on the return weight as against the weight of the natural silk handed to the dyer, which is, of course, 16oz. to the pound; but the percentage of adulteration of a 24oz. and 32oz. return is really much higher than 50 per cent. and 100 per cent., as silk, in the process of "boiling off," loses about 25 per cent. of its weight by the removal of the natural gum; therefore, a 24oz. return in "soft," the trade term for silk "boiled off" before dyeing, is 100 per cent. adulteration and a 32oz. return 167 per cent. adulteration. Blacks are weighted to a higher degree—in warp to 30oz., or 150 per cent., and in weft to 48oz., or 300 per cent.

Goods made of hard, or unboiled, silk are not regarded as adulterated, therefore the restoration by artificial means of the 25 per cent. lost in the process of boiling-off is considered legitimate, and has been customary for at least 200 years; but the modern charging of silk has been carried to such an extent that a fabric may consist of two-thirds adulterant and only one-third silk, and yet be sold as an "all silk" material, and in spite of the latest improvements in weighting by means of an after-treatment, which tends to preserve the elasticity and lasting powers of the thread, such a material after short wear will crack in the folds and tear like tinder, and even without use or exposure often become, after a few months' storage, completely rotten.

It is a fraud to sell composite goods of silk and other yarns, including wood-pulp yarn, as "all silk" goods, and the vendor of such goods is liable to prosecution under the Merchandise Marks Act, 1891.

It may, of course, be taken for granted that no respectable firm would knowingly run such a risk. Care is, therefore, taken to describe goods, certainly if invoiced, with some regard to accuracy; but where the adulteration of goods is brought about by means of loaded dye, the conscience is not so delicately balanced, and it is the exception rather than the rule for "all

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silk" goods to be really and indeed genuine in this respect. Goods of heavily-weighted dye are not only more subtle in their deception, but their wearing qualities are undoubtedly inferior to those of all pure silk or of pure silk mixed with other yarns. It is therefore most desirable, in the interests of the industry, as well as of the consumer, that this pernicious practice should at least be confined within those reasonable limits mentioned, or else that such goods should be prohibited from being sold either as "all silk" or "silk."

Under the heading of "SILK GOODS" it must be admitted that long-standing custom allows of certain cloths, which are a mixture of silk and some other yarn, being sold as silk. Irish poplins, for instance, are silk goods, yet they are composed of a silk warp and a wool or worsted weft. Silk velvets or silk plushes, providing they have a silk pile, may have cotton backs, or silk linings may be either satin or twill faced, made with a silk warp and a cotton weft, and yet be called silk. Although some difference of opinion probably exists as to when goods may be justly termed silk and when they may not, everyone is agreed that materials which contain no silk whatever should not in any circumstances be called silk. And yet it sometimes happens that goods are offered and sold under the name of silk which are composed entirely of other yarns, such as mercerised cotton or wood-pulp yarn, both of which have, in a varying degree, the brightness and glossiness of silk. Deceived by the appearance and lured by the cheapness, the public buy such materials with avidity; later on, when the lack of true silken characteristics is revealed, and the fleeting wearing properties discovered, it is the name of silk which is reviled and the maker of the genuine article who suffers.

As to the proportion of silk an article must contain to be called silk, opinion in the trade is that in any case the warp should be silk, and that the article externally should be wholly or mainly silk—that is, silk free from excessive adulteration in the dye.

Artificial silk, not experimentally, but as a commercial product, is entirely of vegetable origin, in all processes so far used in its manufacture. Artificial silk is dyed with cotton dyes, not with those used for silk.

The names of the various makes or varieties of cloths which are by general consent regarded as silk goods are legion. Those more generally known are classified under the following headings:—Taffetas, satins, twills, armures, gauzes, diaphanous tabbies, fancy and figured silks, figured silks for furniture, and velvets.

THE NAMES OF VARIOUS RECOGNISED MAKES OF SILK GOODS.

Taffetas.

Taffetas Mousseline.
" Chiffon.
Gros Grain.
" de Tours.
Royale.
Faille Française.
Poult de Soie.
Epingle.
Gros de Suez.
Moire Française.
" Antique.
Fancy Moires.
Gros de Naples.
Pongee.
Tabaret.
Lustring.
Bengaline de Soie.
Glacé.

Silk Warp, Wool Weft.

Irish Poplins.
Popeline.
Bengaline.
Veloutine.
Velours Victoria.
Cotele.
Sultane.
Poplinette.
Sicilienne.
Crépon.

Satins.

Satins, Yarn dyed.
" Piece "
" Mousseline.
" Messaline.
" Lumineux.
" Charmeuse.
" de Lyon.
Peau de Soie.
Radzimir.
Rhadames.
Satin Chine.
Soie de Deuil.
Merveilleux.
Radium.
Meteor.
Duchesse.
Soleil.

Silk Warp, Cotton Weft.

Satins.
Polonaise.
Striped Coat Linings.
Moirette.
Satinet.

Twills.

Sarsnet.
Surah.
Serge.

Armures.

Louisine.
Tricotine.
Natté.
Barathea.
Royale.
Rep.
Ottoman.

Gauzes.

Chiffon Gauze.
Muslin Gauze.
Leno.

Diaphanous Tabbies.

Ninon.
Tulle.
Voile.
Marquisette.
Aerophane.

Fancy and Figured Silks.

Stripe.
Check.
Broché.
Chiné or Warp Printed.
Printed Piece Goods.
Damassin.
Foulard.
Brocade.
Figured Tissue.
Striped Tabaret.
Matelasse.
Chevron.
Losange.

Figured Silks for Furniture.

Damask.
Damasquette.
Brocatelle.
Lampas.
Coteline.
Arras.

Velvets.

Trimming Velvet.
Dress Velvet.
Collar Velvet.
Miroir Velvet.
Velours du Nord.
Velours Chiffon.
Plushes.
Velours Sabre.
Panne Terry.

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To return again to the question of the reason of the great decrease since 1851 in the number of our silk workers, although all over the world, as power-looms displace hand-looms, and constantly improving labour-saving machinery is introduced, there is naturally a shrinkage in the proportion of the number of workpeople to the output of goods, I am quite sure that no one, no matter what his fiscal opinions may be, will contend that our abnormal shrinkage is entirely attributable to that cause. And although I have no desire to make my paper in any sense an excuse for fiscal controversy, it must be admitted that the collapse is largely due to the abolition of the 15 per cent. duty on foreign goods in the year 1860. I advance no arguments on the prospective merits of Free Trade and Protection, as to whether the one or the other is better suited to any particular trade or industry, or to our national well-being as a whole, but I say most emphatically that the slight barrier of protection which the silk industry enjoyed could not have been broken down at a more unfortunate time. Only nine years previously, at the first great International Exhibition of 1851, it was clearly demonstrated that this country was so hopelessly outclassed in art as applied to our manufactures, that we could not hope to compete with the productions of Continental countries unless we set to work to organise a system of art education in design and colour so thorough and practical that the rising generation might bring to the industries a refinement of taste and culture necessary to their welfare. It could not be done in a day, nor yet in a decade. Schools of design had first of all to be established and teachers of design taught, and, more difficult than all, those engaged in industry persuaded to submit their young people to a course of art training; but long before any of these things could be accomplished the pent-up flood of foreign competition was suddenly let loose upon us, and our silk industry swept away like so much sand. What is the result? Since 1860 we have imported silk goods of foreign manufacture to the value of £609,084,703. If it be true, as some people contend, that under any circumstances our silk industry was doomed, then it is clear that had the 15 per cent. duty remained, the handsome sum of £91,362,705 would have been added to our national income.

But it is argued that, as a result of our free market, enormous quantities of silk goods are imported for reshipment to colonial and other markets, and that the agent and the merchant have replaced the manufacturer. I regret to say I can find no consolation in the statistics which the Board of Trade provide. Our total exports of silk goods since 1860 amount in value to £90,677,329, and as our exports in 1861 were valued at £1,395,582, and in 1911 at £1,851,136, it cannot be claimed that in this branch of trade we have made any striking development. Nor is it likely to extend, for as our overseas customers develop their power of purchasing they are bound, particularly under our present absurd Merchandise Marks Act, which compels exporters to declare the country of origin of every article, to discover the actual source of production and so avoid the middleman. This phase of the subject is every day becoming painfully evident to the merchant exporters of foreign goods, and as time goes on, they are bound to realise more and more that a safe and growing trade can only be done in goods of home manufacture. That brings us face to face with several vital questions. Are we making goods to-day so unique in character and in such quantities as to supply not only the home market, but also our shippers for trade in foreign markets? My reply is that in certain varieties of goods we are and have been for many years supreme, whilst in others we are by degrees building up a world-wide reputation.

To begin with, English spun yarns are without an equal in the world. They are finer, more perfect in structure and finish, and of greater evenness in strength than any yarns spun abroad, For these reasons they are in great demand, both here and abroad, for warp purposes, and for the manufacture of certain cloths are indispensable.

As in the cotton industry, so in the silk. As the Continental spinners advance in the manufacture of the cheaper, coarser yarns, making competition keener, and reducing profits to vanishing point, the English spinners confine themselves more and more to the yarns of higher grade. In woven goods our rich quality mufflers, handkerchiefs, and tie silks are unapproached by anything made abroad. In crape, crêpe de chine, and similar goods, we are pre-eminent, and we can honestly say that with regard to umbrella silks ours are the only ones worth having. In the manufacture of decorative textiles for wall hangings and furniture, we have a colossal competitor in the French, but in spite of that the products of our looms are equal to their best productions, not only in design and colour, which is the manufacturers' work, but in the beauty and perfection of weaving, which we owe to the intelligence and skill of our workpeople, many of whom possess the refinement

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of touch and innate love for the art of weaving unsurpassed by the best of foreign artisans.

We must plod on patiently and continue to do our utmost to gain a reputation for beautiful and reliable goods. Twenty years ago our silk industry was regarded, and always spoken of, as a dying industry. It is not so to-day; at death's door we have secured a new lease of life. Losing weight in the struggle, we have thrown off the old lethargy, renounced despair, and are training ourselves on sounder principles to meet the world's never-ceasing, ever-changing competition, in which, if we cannot succeed, we at least mean to deserve to do so.

Tacitus says: "More energy and greater perseverance are found among the wretched," but I would rather say that "difficulties provide the thicket through which men of courage and ability fight their way to honourable achievement."

That is the measure of our strength. What of our weakness? Our industry of silk-throwing is very small indeed; it is a mechanical process dependent for its perfection on the latest improvements in machinery, and for its financial success on a plentiful supply of cheap labour. In this country it has found the one, but not the other; so it has gone abroad, mostly to Italy, where both conditions are complied with. Cheap plain silks, the demand for which for dress purposes is so enormous, require the same conditions, and these are more favourably met with in Switzerland and Italy than here. Medium quality figured silks for dress and decorative purposes are scarcely made at all in this country; they are goods of everyday demand. Price, which is again dependent on the cost of production, is one of the vital factors; but others, such as design, colour and originality of cloth construction, are equally important. In the direction of the manufacture of such goods, I cannot help thinking there is a great opening for enterprise on our part; the trade done in these silks is so extensive, and the variety so unlimited, that manufacturers possessing the requisite qualifications in design and colour should be able with some spice of originality to nullify the foreigner's only remaining advantage of lower cost of production.

Such a venture would mean the risking of capital and a large measure of confidence, which to-day in this country are difficult to find; but, in my opinion, the opportunity of a considerable and profitable manufacture of these goods exists, and until it is tackled on a large scale we cannot supply either our own or foreign markets to a reasonable extent with goods of home manufacture. Against this optimistic view of possible development there is the view of many manufacturers, equally well qualified, who point to the almost daily advertisements of distributing houses who offer Lyons silks of many kinds at half their original cost, and ask how it is possible for manufacturers here to compete under such impossible conditions. It is undoubtedly a contention so true and so serious that it cannot be ignored. Lyons houses do not care to unload their surplus or remnant stock on their own market, so a great deal of it comes here and is offered to the public at prices which no *bona fide* producer can compete with. They are not up-to-date goods, but the British public is ignorant of the fact and is satisfied.

I am frequently shown these goods and told that English manufacturers can produce nothing like them at the price, that they are "out of it," as, of course, they are. From mere curiosity I have more than once gone to the trouble of finding the manufacturer of these goods, and have discovered that the particular designs were discarded patterns of two years before, and that the manufacturer's price for the materials was more than double the price at which the consumer bought them here in a retail shop. Of course, the distributors have a perfect right to do as they please, and undoubtedly they consider they know their own business best, but since they all have an equal opportunity in dealing in these job Continental goods, I fail to see that it is individually of advantage to any one of them. It certainly does not put the stamp of uniqueness upon their wares; it cannot prove an attraction to French or other foreign visitors to this country, and it drives the really smart society woman to Paris for her up-to-date gown. Happily, there are a few firms in London which adopt another and better method of buying; they work in hearty co-operation with the home manufacturer, discuss design, colour, and make with a view to the creation of beautiful and original stuffs, and, as a result, the goods they offer to the public are unique in character, sound in quality, but inexpensive, and command a sale not only in this country, but abroad. The reputation of British silks for men's and women's wear, as well as for decoration and many other purposes, is being established all over the world by these patriotic firms, and they are losing nothing financially, but are, on the contrary, well known for their exceptional prosperity.

Successful business is not founded on mere sentiment, but on solid commercial principles;

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greater and more permanent success can be achieved, however, by the co-operation of producer and distributor, if both are working on sound principles, than by the more ordinary cheap-jack "beat-your-neighbour-out-of-doors" methods of much of our present-day commerce. My belief in the possibility of the successful manufacture of medium quality silk goods in this country is based on the certain help which many distributing firms would readily give such a venture, providing that the productions were original in design, tasteful in colour, suitable in texture, and that the general needs of the trade were met as regards widths, manner of packing or folding, quantities of a particular design and colour, and conditions of credit.

Nothing is so helpful to the reputation of an industry as its development in an artistic direction. A few firms, even a few individuals working on independent and original lines in the production of beautiful goods will give a tone to the entire industry, and that character, once established, is an asset so valuable that its benefits will last long after the creators of it have passed away. Take Italy as an example: she at present shows no development in design for silken fabrics, and, with the exception of the repetition of her old designs, her productions are very poor. But so great was the reputation established by Italian designers of fabrics in the fifteenth, sixteenth, and seventeenth centuries, that the world will always seek for Italian silks for decorative purposes, and the looms of the modern Italian manufacturer, with no claim to personal merit, will be kept busy.

France might be quoted in a different sense. Her reputation for design and colour, based largely on the past, is upheld by her present skill and refined taste. All French manufacturers do not produce beautiful things by any means, and yet a Frenchman selling in London, the merit of whose goods is quite unknown, will generally, almost always, obtain an entry to the buyer, and receive greater consideration for his wares than the manufacturer or merchant of any other nationality. Helped by his country's known character for refined goods of artistic manufacture, his battle in selling is more than half won by the readiness and courtesy with which he is received by the possible purchaser and by the popular prejudice in favour of his goods. If any proof were needed that this is so, I will here mention the fact that I have frequently seen English-made silks, both cheap and pretty, that have been unsaleable to the English distributor until they have been sold to a Paris house, which has then offered them here under French names at a higher price, and sold them with success. A good reputation is a valuable asset for a nation as for an individual. Does this country possess one in connection with the manufacture of silk goods? In my opinion, it not only has an old-established reputation for honesty in the quality of the goods it manufactures, but it is rapidly building up the still more valuable and lasting one of purity and originality in design and unique taste in the selection and blending of colours; art, in fact, has stepped in to robe our industry with her unfathomable beauties and inextinguishable fame. The movement was begun by William Morris, who included the weaving of decorative silks in his multifarious and wonderful works of art, and by my father, Benjamin Warner, who devoted his whole life to the manufacture of silks and velvets chiefly for furniture and hangings for church purposes, and brocades for Court gowns. He was the only man I ever met who combined an absolute knowledge of the construction of the most complicated fabrics with a sound knowledge of design and an inborn taste for colour.

The splendid pioneer work which these two renowned art-craftsmen—unfortunately now no longer with us—initiated is now being energetically followed up by an increasing number of able and devoted workers, who are daily bringing fame as well as prosperous trade to the artistic section of our silk manufacture, which must and does reflect beneficially on all other branches of silk manufacture in this country. Whether realised or recognised, it matters little—the waves of good influence, like those of bad, spread far and wide, and however unsusceptible we may be to our surroundings, the far-reaching effect of good work remains. Silk does not stand alone in its artistic development. All our industries where art is applied are advancing to a higher standard of excellence, and in almost every industry and handicraft one finds beautiful work being done which is unsurpassed by foreign productions. As an example, I would mention the decoration and furnishing of rooms which is now being done with such exquisite taste by several firms in this country. The display made by these firms at Brussels in 1910 was dignified, classical and beautiful. At one bound it established the character of English decorative art as being higher than it has stood since the days of the Adam Brothers and Chippendale, and quite on a level with, although different from, the best work of the French. Not only has that display brought good business from all parts of the world

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to those enterprising exhibitors, but it has raised the whole decorative and furnishing trade in this country to a higher plane. Nor does their good influence on our productions end there, for in their efforts to improve, other industries, such as those of metalwork for stoves, brackets for lighting and other fittings, carpets, tapestries, and printed textiles, wall-papers, etc., are stimulated to create better work, and these industries in turn re-act in a similar way on those closely associated with them.

The Brussels Exhibition, just mentioned, recalls the magnificent display of British silks which our manufacturers very pluckily made there. As a demonstration of our ability to make lovely silks of all kinds, it was an immense success, and nothing to equal it of purely British origin had ever been seen before. Some praise of it appeared in the British press, but the real spontaneous and most valuable appreciation came from foreign experts, French, German, Belgian, and others, either casual visitors to the Exhibition, or members of the international jury, whose generous testimony to its sterling qualities I delight in recognising here. Seventeen firms participated in the first display, which was so disastrously destroyed by fire, and in the reconstituted British section nine firms again came forward with extensive and equally meritorious exhibits.

To our King and Queen, patrons of the Silk Association, and ever ready to forward the interests of the British industry, this display at Brussels, synchronising with the all-round improvement in home silk manufacture, must have brought much satisfaction. It affords a practical demonstration that their royal patronage, so readily and continually given, has been attended by definite and beneficial results, and it will be equally gratifying to other enthusiastic workers in the cause of British silks, such as the Duchess of Sutherland, who so kindly placed Stafford House at the disposal of the Silk Association for the Silk Exhibition of 1894, and to the Hon. Mrs. Percy Mitford, who for thirty years has worked strenuously and unceasingly in advocating the use of silks of home manufacture.

The recent history of the silk industry and its present condition having been amply considered, let us now turn our attention to the all-important phase of it—its future.

I have no apology to make, but it almost seems out of place to talk about the future; it is the fashion nowadays to disown posterity, to speak of it in a mean spirit, to cast it aside as having no claim upon us. We forget that to a past generation we are posterity materialised, and that all our privileges and blessings are the direct and immediate outcome not only of the toil, suffering and sacrifice of our predecessors, but of their care, thought and interest in what to them was the future. "Let futurity shift for itself," or "Posterity has done nothing for us; why should we do anything for posterity?" are expressions now heard every day. Such egoism, revolting and unnatural in the individual, will result in national ruin if put into practice. Besides this, we must ever remember that we can no more sever ourselves from posterity than we can cut adrift from the past; everything we do, wise or foolish, will affect the future. The warp in the loom is eternal in its length; it is at present our privilege to weave upon it, and we make good or bad work according to our ability or our determination, but at least it is our duty to leave the loom at last so that those who come after us may do better than us. Bad or indifferent work is mostly the result of ignorance or inefficiency due to the lack of education. Proper education in the silk industry means a thorough training in applied science and art for all those who are later on to control and guide it. A complete course of tuition in the technicalities of silk spinning, dyeing, weaving and finishing, supplies the knowledge of the composition and properties of yarns, such as their strength, nerve, and lustre, which is necessary in determining their adaptability to the various types of cloth, the selection of appropriate dyes for certain classes of silks, either pure or weighted, the knowledge of the manipulation of the warp and weft threads to obtain certain effects in cloth structure, either old or original, the application of design to a suitable make of cloth, the construction of the loom for all classes of plain weaving and for all types of design and processes necessary for the treatment of the cloth when woven.

The training in applied art provides the teaching of drawing of natural forms, particularly of plants and flowers, animals and the human figure, an introduction at least to the bearing of architecture upon design, the study of the recognised styles of design of past periods, and a training in the blending of colours.

The science training provides the body or fabric, the art training the soul or character by which it becomes known, or an individuality which distinguishes it from anything that has ever been made before.

Technical training alone may suffice for the initial stages of silk preparation, but in all its

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higher branches science and art must go hand in hand, not in dilettante fashion but strenuously, if we mean to establish our silk industry on a firm and indestructible basis. In the past, fifty years ago, whatever the desire, there was not the opportunity for this training; to-day there is much opportunity, but, if anything, we have not fully awakened to the desirability of it. If we had, I am confident that the widest and most complete provision would speedily be made. If we were only as convinced of the vital need of these aids to our industry as we ought to be, and agitate with the same strength and fervency as we do in connection with such questions as the misdescription of goods or national insurance, they would soon be forthcoming.

Two years ago a Departmental Committee was appointed to consider and report upon the functions and constitution of the Royal College of Art, and its relation to the schools of art in London and throughout the country.

The investigations of that Committee led not only to the discovery of the existence of extraordinary conditions in our system of applied art training, but verified in a striking manner many of the objections and complaints that for years have been lodged against the methods of art teaching in our schools.

As the Committee's report has probably not been generally read. I will quote some extracts from it. The first is a very important one, being a clear recognition that handicraft, however meritorious or interesting, must give way to the claims of the manufacturer, upon whom rests the responsibility of maintaining our trade both at home and abroad, and that he can only compete successfully when, through his designer, who is both technically and artistically trained, his goods have superior merit. The report says:

"So far as the principal industries of this country are concerned, the methods of handicraft have long been replaced by those of the factory. It is the factory which supplies the innumerable articles of personal wear and domestic plenishing, constituting the staple of that section of British trade at home and abroad which can be regarded as in any way dependent upon Art. Form and pattern of one kind and another are an important element in the competition between manufacturers of such wares, and tend to become even more important as the differences in mechanical efficiency between trade rivals grow less and less. But they must be form and pattern which are capable of being impressed upon the goods by processes subject to definite mechanical limitations which have to be learned, so that the designer who controls them must study the conditions of the textile power-loom rather than of the embroidery frame."

My next quotation will show you how lamentably the students turned out by the Royal College of Art have failed to bring to the industries the artistic influence which it is their function to provide, and as a consequence much of our designing work is done by foreign designers.

"It might be expected that the College of Art, if the students fulfilled these conditions, would exercise that influence over the artistic trades of the country which it was founded to exercise, and that the designers, who have passed through its course and have obtained the hall-mark of its Associateship, would be eagerly snapped up by business men. All the evidence which we have been able to collect from many and diverse sources of information has brought us to the regrettable conclusion that this is not in fact the case. The needs of the industries are met in various ways. Many designs are supplied by architects or other artists who have turned their attention to industrial art. Many are purchased, especially in the textile centres in and about Manchester and Bradford, from French designers. Thus the Calico Printers' Association, who spend £37,000 a year in designs, maintain sixteen designers in full work in Paris, as well as thirty-eight in England. Designs prepared in England supply the Indian market, those from Paris the markets of England, Europe, and America. The Wall Paper Manufacturers' Combine prefer German designs for technical adaptability, French designs for artistic skill. Of the firms which employ regular designers, some train them in their own drawing offices, others find a supply in the local schools of art. Very few of them ever think of looking to the Royal College, and although some who have tried the experiment have been repaid, we find the opinion widely held that the type of designer turned out by the College is, from the manufacturing standpoint, 'unemployable.' 'For any effect the Royal College of Art has on the designing world, you may take it that it has none at all,' said one witness; or, as Dr. Garnett more sympathetically put it, 'The Royal College of Art, as a college to command the confidence of the trades, has to do a good deal more to win its way.'"

The complaint set out is by no means confined to the Royal College of Art, but is also met with in many provincial towns where industries require the aid of practical and artistic designers. This often arises from a lack of sympathy and co-operation between those who control the administration of art culture and those who are engaged in the manufactures and need the product of the art schools. It also, in part, arises from a deeply-rooted prejudice on the part of many art teachers to machinery and machine-made goods. They know that the mass of gaudy, cheap, horrible rubbish seen in the

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shops and bazaars to-day is machine-made, which, of course, it is, and therefore they have a horror of machinery, and resent the application of their talents to preparing their students in any way to provide for its requirements.

As a matter of fact, machinery will produce the most beautiful designs as easily as the most detestable, and the refusal of art school teachers to recognise this fact has placed a very heavy handicap on our industries. The report deals with it as follows:—

"We cannot resist the conclusion that the failure of the College to influence manufacturers rests upon something more fundamental than can be explained away as the result of mere prejudice. There is undeniably at present a real want of sympathy between the aims of art and the aims of commerce. This is not in the least because there is any essential difficulty in finding artistic expression through the medium of a machine. As a witness who had had experience as head of the design studio of more than one great distributing house, and been himself exceptionally successful in the training of designers, put it to us, the requirements of a machine are, as a rule, 'by no means unæsthetic,' and, in fact, design for handicraft, just as much as design for manufacture, has to accommodate itself in a greater or less degree to the limitations and conditions imposed by the appliances used. A hand loom or a potter's wheel is, after all, although it allows the hand to contribute more, no less a machine than is a power loom. The same witness's main criticism of the students from the College was that they had acquired a theory and an ideal which 'it was very difficult to knock out of them.' The training of designers in the past has no doubt been too abstract in character, and has taken too little account either of the conditions of machinery or those of material, or of the economics of production. Some of us are disposed to hold that the real problem lies primarily not in any supposed barrier against the production of beautiful things by machinery, for there is none, but in the fact that the public, which the manufacturers serve, does not, for whatever reason, purchase beautiful things, the fault being attributable in varying degrees to the taste of the purchasers themselves, to the taste of the manufacturers, and to the taste of the retail salesmen, with whom, rather than with the purchaser, the actual choice between this pattern and that is supposed to rest. But the soundness of this view must lack proof until the College has provided the manufacturers with designers equally competent from the technical and from the artistic standpoint, and until the manufacturers and the public have shown a deliberate preference for the baser sort of design."

You will notice that part of this quotation dwells on a very important feature of our industrial problem—viz., the taste of the manufacturer, of the purchasing public, and of the retail salesman, who stands between the two. The whole thing summarised amounts to this—that if the manufacturer is able and willing to produce articles of real artistic merit, and the public are desirous of purchasing them, the retailer has it in his power to render abortive the aims of the one and the desires of the other.

It is a very serious matter, and we may well ask the question if the retailer exercises his power in such a way as to check the production and use of artistic goods. It is a very difficult question to answer, but, on the whole, I should say he does not. In many cases the retailer buys with taste and skill, based on some artistic leaning, if not on actual training; in others he rejects beautiful patterns and favours bizarre and *outré* productions. In this matter I think the whole three hang together —I mean the manufacturer, the retailer, and the consumer. All of them equally require a thorough artistic training, which at present but few of them get. The influence of the one reacts upon the other, and as a general upward tendency in the direction of art culture prevails, our production of silk as well as of other things will improve.

The report goes on to say:—

"It is in any case admitted that there is a demand, and perhaps a growing demand, for beautiful goods from a certain limited public, and that individual manufacturers may quite possibly find it to their profit to make a corner in this specialised trade, but this consideration leaves the great mass of textile and other manufacturers, upon which the economic question turns, wholly unaffected. Were all causes of reproach against the Royal College of Art removed, it is not to be expected that a sudden revolution in taste will be worked, or that better-class design will win the confidence of the manufacturers and the appreciation of the public in a day."

Exactly so. Art education, although it but touches the merest fringe of the people, is having an immense influence in the direction of a demand for better things. Remember that art training in connection with our industries does not date back many years. In 1851 it stood almost at zero, and although since then we have accomplished much, the great mass of the population remains untouched by any direct art training, and in its choice of what is good or bad has nothing to guide it but the influence of its surroundings, which in all honesty we cannot claim as providing in the main an atmosphere

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of artistic thought and leaning. The following quotation from the report is most interesting:—

"As a first step to employment, the students must obviously be equipped to be competent component parts of the industrial machine, as well as artists. Hitherto 'art schools have been occupied in one direction, and the trades in another.' When that unhappy condition ceases to obtain, it will be possible to decide how far the efficiency of the industrial machine is compatible with the cultivation of art. A good illustration of the present divergence between the commercial and artistic attitudes towards design is afforded by the controversy upon 'styles,' which has more than once been argued before us. The luxury of an age which has absorbed archæology, rather than art, desires rooms decorated and upholstered in the historical manners of certain English or Italian or French periods. The work is highly skilled, and demands both erudition and adaptability. The producers complain that the public which they serve will have 'styles,' and that the Royal College of Art students have a wholly negligible knowledge of the history of design. The artist, on the other hand, dislikes the reproduction of 'styles.' For him the study of historic ornaments is rightly an invaluable discipline, provided that it leads not to archæology, but to the formation of a personal style of his own, based upon tradition, but representing an advance upon tradition, and giving expression to his own sense of beauty and fitness rather than to that of the conjured ghost of a bygone century."

To the manufacturers of decorative work of all kinds, and to decorative textiles in particular, this question of styles is an all-important one, and will probably remain so as long as the world lasts. Archæology is therefore of vital necessity to all who are engaged in the trades of building, decoration, and furniture. If we fail at all, it is in the insufficiency of our knowledge of it. Why, then, should our art schools, which are founded and maintained by the State for the express object of assisting the manufacturers of this country by means of art training, ignore it? And yet it is ignored. In fact, it is banned in most of our schools, and, as a result, so-called art students, imperfectly taught in drawing and absolutely uncultured in design, seek in vain for employment in trade *ateliers*. All they have acquired in design is a wretched mixture of poorly-drawn plant form of a semi-conventional nature, with a dash of mediævalism, introducing a meaningless wooden bird or animal, the latter probably the result of badly-directed museum study, the whole thing useless, impossible, and inapplicable for reproduction in any form whatever. Please do not misunderstand me. I do not ask that originality should be discouraged; on the contrary, there is now, as there ever will be, a great opening for new work of distinguished merit, which surely cannot be hindered by a knowledge of historical ornament. But we know that the great mass of art students are not gifted in this direction, and it is therefore little short of criminal to stunt their prosperity by denying them a training which, next to drawing, is the most valuable they can acquire. Really it would be a good thing if most of the schools would concentrate on drawing and leave designing alone. Here and there fortunately we find schools where training is conducted on more practical lines, and in active sympathy with the needs of the industries, and whose work is kept in close touch with the technical side of manufacture. Macclesfield and Bradford are invaluable aids to the silk industry through their art and technical schools, and owing to their direct influence much of the advance in the excellence of silk and other textile production is attributable. Whilst this is generally recognised, much remains to be accomplished. This the report deals with as follows:—

"If the training of designers is to be kept in close relation to the industries, it must in the main be carried on in the actual centres where those industries are located, and where alone the necessary equipment can, without reasonable expense, be made available. There are established and well-equipped schools in most of the great manufacturing centres, and we would urge that each of these should be encouraged to specialise in the needs of its dominant industry, and to obtain the position of a provincial college, to which industrial students might be drawn from the whole area over which the industry is spread, and in which they might receive an advanced training in design with a direct application to the special needs of the special industry. Thus Manchester, Bradford, Kidderminster, Macclesfield, and Stoke-on-Trent would become seats of great monotechnics serving respectively the needs of the cotton, woollen, carpet, weaving, silk and pottery trades, and we would particularly dwell upon the importance of treating the scientific and artistic aspects of technical instruction in two departments of a single college, and thus breaking down the isolation in which a school of art too often stands at present in relation to other educational institutions in its locality."

Following this, let me quote the first two recommendations of the committee:—

"1.—That the training of designers for the manufacturing industries should be specialised, and should be undertaken by provincial colleges of art, each of which, while continuing to provide a general education in art, should devote special attention to the needs of the dominant industry in its locality, and to this end should take steps to associate with its work representative manufacturers and artisans belonging to the industry."

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"2.—That these provincial colleges should be conducted as departments of colleges which deal with the scientific as well as the artistic sides of the dominant industries in their localities."

To all engaged in the artistic industries, and in silk manufacture in particular, these recommendations are the embodiment of their desire, long and eagerly sought for, to provide education in its most practical form for its most vital needs. If adopted, they will result in the uplifting of our whole industrial attainment to a standard dreamt of, perhaps, but hitherto unapproached by anything attempted or achieved in the past.

If we have a duty remaining, it is to see that these valuable recommendations are carried into effect, and not left unrealised. The vital need at the moment is that our industry should be raised and left no longer entangled in the weeds of past inefficiency, technical or artistic.

I cannot close my paper without referring in all gratitude to the inspiration and example which the long and precious life and high character of our revered chairman, Sir George Birdwood, have set us. His efforts on behalf of the Kashmir Silk Industry date back as far as the year 1861, when he was the first to call attention to the possibility of sericulture in that province of India, which led to its development under the enthusiastic guidance of the late Sir Thomas Wardle. His unflagging interest in the British Silk Industry, his conviction of its present technical and artistic merits, and abounding faith in its future, his great knowledge and abilities in connection with a vast range of subjects, particularly those of a refined and sumptuary nature, and his graceful and learned speeches on all topics, appeal to us and incite our warmest admiration.

To recall Shakespeare's words :—

"He was a scholar and a ripe and good one,
Exceeding wise, fair spoken and persuading."

Or to quote Browning :—

"One who never turned his back, but marched breast forward,
Never doubted clouds would break,
Never dreamed, though right were worsted, wrong would triumph,
Held we fall to rise, are baffled to fight better,
Sleep to wake.

"No, at noonday in the bustle of man's worktime,
Greet the unseen with a cheer,
Bid him forward, breast and back as either should be,
'Strive and thrive' cry 'Speed—fight on, fare ever,
There as here!'"

DISCUSSION.

The Chairman (Sir George Birdwood) said :—I am in the chair this evening, not only because Mr. Frank Warner's subject is silk, but because he is his revered father's son, and has so worthily followed in his father's footsteps in devoting himself to the promotion of the great revival of the silk manufactures of this country after their collapse between 1860 and 1870, until now, alike in artistry and quality, they equal, and, I will be bold to say, surpass, the silk stuffs produced anywhere else in the world. Owing to my connection, through the India Office, with International Exhibitions, I became acquainted with the late Mr. Warner, as with the late Sir Thomas Wardle, so far back as 1871; and from that year the personal friendship between the three of us grew closer and stronger to the last days of their strenuous, straightforward, and most lovable lives. There was another tie between the late Mr. Warner and myself, in that we were both of French descent —he in the direct line of his paternal ancestry. He used to say that, so far as he had traced his forefathers back, they had always been engaged in the silk industry. He himself was born in 1828, and, on the death of his father in 1839, he had at once, as a boy of eleven, to take full charge of the business of the family, consisting of the widowed mother and his five sisters, all directly dependent on him. I could cite from my personal knowledge of the history of our leading London firms, several instances of family businesses being in this way suddenly thrust upon mere boys, and by them transformed into great business houses; another notable one being that of Messrs. Henry Sotheran and Co., which fell into the hands of the late Mr. Henry Sotheran when he was ten years old. And what a test and proof of the highest character, and capacity, and how inspiring a national glory that such triumphs of moral and intellectual worth should be commonplaces of the industrial history of this country! The late Mr. Warner had also other special qualifications for facing so successfully so adverse a fate, in his remarkably refined artistic taste, both in respect of design and colour, inborn of generations of experience in the manufacture of silks; and, again, in a natural modesty that always left him in imperfect content with his work, and intent only on its further improvement. He instantly removed himself from the school he was attending at the time of his father's death, and began to practise himself in designing for silk fabrics, and in card-cutting, and in plain and figured weaving; while, later on, he studied of evenings at the Spitalfields School of Design, one of the first to be established in this country under the direction of the Victoria and Albert Museum, that glorious memorial of the genius of Sir Henry Cole. This practical training in the mechanical and artistic technicalities of his work was one of the secrets of the late Mr. Warner's success in life, not only as a manufacturer of silks of supreme artistic merit, but also as a trader in them. When he,

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a boy of eleven years, started in life, our "silk manufacturers," as they called themselves, were merely employers of designers, and card-cutters, and weavers; and it was he who changed all this; and so thoroughly that, on the collapse of the silk industry of this country between 1860 and 1870, he forthwith took to manufacturing silk for himself, and from the very outset of the reform he then carried through, it became a source of assured profit to himself, and a timely boon to all the remaining weavers of Spitalfields. It is no exaggeration on my part to say, that no silken textiles, of such excellency in design, colour, structure, and substance, were ever produced in this country before Mr. Warner took the manufacture of them into his own hands; and that to-day the silk manufactures of the United Kingdom are not to be surpassed—and I rejoice to add that the same may be said of our textile manufactures generally, including carpets, and of our porcelain and pottery, and gold and silversmithing—by those of any country of Europe and the Americas. Mr. Warner's efforts were at first restricted to decorative fabrics, but later on they were extended to dress brocades of the richest and noblest types, and with the same creditable and remunerative results; and it was the sumptuous silks Mr. Warner exhibited at Manchester in 1887 that led to the founding in that year of The Silk Association of Great Britain and Ireland, with Sir Thomas Wardle as its first President. Except Mr. Warner's silks, there were no other British silks at that time to give the necessary impulse —*i.e.* the quickening of the enthusiasm of Sir Thomas Wardle and his circle—for the establishment of the Association. The late Mr. Warner was, indeed, one of the great "Captains of Industry" who in our day have given the name of England its most beneficent and enduring titles to fame throughout the commerce of the civilised world. It would be all-sufficient for me to say of the lecturer of this evening, that he is the worthy—I will emphasise it—the brilliantly worthy son of his worthy and worshipful father; but it will be as well to add that he was not only trained to a practical knowledge of the manufacture of silks, but was instructed in the theory of their manufacture, and in the principles of political economy generally at Lyons itself, the very best school of industrial and commercial philosophy in Europe; that he entered the business of his house in 1881; that since 1893–4 he, in the manufacturing department, with his elder brother, Mr. Alfred Warner, in the commercial, have held the entire direction of it; and that, on the death of Sir Thomas Wardle in 1909, he, after a brief tenure of the office by Mr. Boden, succeeded, in 1910, to the Presidency of the Silk Association of Great Britain and Ireland. Indeed, by general and expert education, and matured experience, and wide knowledge of the world wherewith he is preoccupied, and sound judgment, and enthusiasm in his work, and by the subsidiary accomplishments that contribute so much to the perfection of achievement in all great undertakings, there could be no one more competent than Mr. Frank Warner to appear before the Royal Society of Arts on the subject of this evening's paper.

The history of the silk industry of this country is comprehensively outlined in Sir Henry Trueman Wood's paper "Industrial England in 1754" (the year of the founding of the Royal Society of Arts), read before us on April 20th, 1910; while the most interesting details of that stimulating history are to found in Vol. XV.—entitled, "The History of the Walloon and Huguenot Church at Canterbury," and dated 1890—of the publications of The Huguenot Society of London, which have been most courteously placed at my disposal for the purposes of this paper by Colonel Duncan G. Pitcher, formerly of the 3rd Bombay Cavalry, and presently the able Secretary of the Huguenot Society of London. But here I need no more than remind you that England owed her first introduction to the arts and crafts of weaving generally to the Netherlands artisans who were encouraged to settle in this country by Edward III. [1327–99]; that two centuries later an equally warm welcome was extended to the Protestant refugees from France and Flanders by Edward VI. [1547–53], who in 1550 granted them the privilege, still enjoyed by them, to worship in the Western Crypt of Canterbury Cathedral, and by Queen Elizabeth [1553–1603]; that these immigrants were not only weavers of brocades and damasks, and other silken tissues of both high and low grades, but of woollen stuffs of all sorts, "sayes," "bayes," carpets, arras, and other tapestries; and, moreover, included in their number workers in Spanish leather; and in brass in its various applications; and makers of bricks, tiles, and delft; and of paper; and guns and gunpowder; and that it was through the skill, and industry, and high virility of men—who had sacrificed everything on earth, the better as they, in their heresy, mistakenly thought, to serve Heaven—operating uninterruptedly, all through the reigns of Edward VI., Queen Mary, Queen Elizabeth, and James I. [1603–25]—no less than to the contemporary enterprise of the East India Company, and the prowess of our navigators, and naval commanders, that this country, step by step, throughout the seventeenth century, secured that position of industrial, commercial, and maritime supremacy we have ever since maintained, under every strain and stress, unimpaired. By the end of the seventeenth century, 1688–99, the French silks of Spitalfields had become famous throughout the United Kingdom. But, all the same, this now naturalised French industry suffered from the very first from the importations of Chinese and Indian silks, and, still more, of Indian "chintzes" ["painted," cf. *cheetah*], by the East India Company. The silks of India and China were far richer than ours, and the flowered calicoes [so called from Calicut, their first place of export] much cheaper; and, as Sir Henry Trueman Wood has told us, Queen Mary herself [the wife of the Dutch conqueror of England] had a great love for these

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lovely "painted" cottons from Sadras and Masulipatam; and so, from about 1689-1714, the silk looms of Sandwich and Winchelsea began to be more and more concentrated in Spitalfields, until by 1837, none were, so far as I have ascertained, left in Kent. The commercial policy of universal "Free Trade," adopted by us in 1846, which in the process of the suns raised the British Empire to the greatness and glory it attained under the sceptre of Queen Victoria, at once filled Spitalfields with dismay, and indeed disaster, but, as I have already indicated, thanks to the late Mr. Warner, never drove it to despair; and to-day, chiefly through his intelligence, sagacity, courage, and steadfast endurance, and the discovery by Lord Masham in 1891 of a way of spinning Indian "chasum," as it is so absurdly designated, the manufacture of silk throughout this country has become established on so firm a foundation that, to all outward seeming, it should never again be seriously shaken.

The secret of this great retrieval is that of all human retrievals—the resolute rising of wise and brave men superior to every fate of evil; and it was simply in this heroical way that the more notable of our silk manufacturers, quietly, patiently, and determinedly facing the stark competition to which they have been exposed ever since 1843, by restricting the output of their looms to the production of the highest and costliest denomination of silks—in a word, by specialising in excellency, absolute excellency, in material, and tissue, and colour, and decoration—have at last brought them to a pitch of perfection, where only the gorgeous and resplendent rolls of the deftly-sleided silks from off the looms of Lyons can be set beside them on any equality of footing. This is the redeeming spirit that in every age has inspired the men who have been the makers of human civilisation; and happily it is the spirit that still animates Englishmen in whatsoever they do, be it on the battlefield, or at the cricket pitch. "Play up and play the game" in every struggle of life; and long though the struggle continue, in the end we shall always come out of it with enhanced reputation, joyfully bringing the recaptured "Ashes" with us!

Apart from the controversy between "Free Trade" and "Tariff Reform," the immediate practical problem before the silk manufacturers of the United Kingdom is that of the arrangement of some *modus vivendi* between them and our great distributing houses—our Whiteleys, and our Harrods. I do not ask the manufacturers, or the distributors, to be influenced by any sentimental motives in coming to some such understanding as I am here suggesting, and for years past have publicly advocated. Sentiment, if yielded to in business matters, will only lead you astray—the desire to please each other, the desire to please our Colonies, whose people are far too level-headed to reciprocate such nonsense. Our distributors must stand by the multitude of their buyers, by the poor men like myself. But our distributors should not ignore our manufacturers; and if the latter are not set aside, as men hopeless to bargain with, our manufacturers will soon show that they can make low-priced goods as well as high-priced goods, and far better goods than any foreigner can supply at the same prices. It is in this way that I would have our manufacturers meet our distributors—who at present are the backbone of our Free Trade commercial system—and it is in such an understanding as this, that, in my conviction, both our distributors and our manufacturers will, in the result, find their exceeding great reward; and the people of Great Britain and Ireland an enhanced stability in the main sources of all that makes for our national security and peace, and prosperity, and happiness.

MR. E. W. COX congratulated the author on his most excellent paper, and said he was sure silk manufacturers agreed that they owed him a debt of gratitude for the very efficient manner in which he had demonstrated that within the last decade the silk industry of the country had not only continued in existence, but had made a certain amount of progress. The old question, "Oh! do you make silk in England?" seemed to have lost its point, thanks very much to the work of the President of the Silk Association, whose exhibit at the Brussels Exhibition was the delight and admiration of all the jurors. Personally, as a wholesale distributor, he naturally had to seek the whole world over for goods for his customers, but underneath that trade instinct he possessed a trait which was not very prevalent among some of their friends, namely patriotism. If this country was in a position to manufacture the beautiful silk goods that were exhibited on the walls, the manufacturers ought to be encouraged. He was happy to say that only during the present week he had had delivered to his firm a most excellent sample of English-made goods of the latest patterns, whose colourings were equal to any to be obtained on the Continent, while the price compared most favourably with that of the foreign article. He hoped the Silk Association would induce the manufacturers to do something to show that they really existed; in particular, he hoped they would exhibit at the forthcoming Exhibition. The day was past for hiding their light under a bushel; and the idea that they would have their goods copied before they were properly launched in the market was dead and buried. Those who visited that Exhibition would, he was sure, see an admirable example of what British silk manufacturers could do. Personally, he was of the opinion that there was not a single article at present made of silk that could not be manufactured in this country, although there was no doubt that some of the manufacturers did not know what their mills could produce and had produced in days gone by. He recently had access to a book which contained patterns of manufactures of British silks from 1830 to 1848, and among them was a certain design which took his fancy. He went to

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the supposed manufacturer, who, however, said in reply to his inquiry that his firm had never made such an article. That particular manufacturer subsequently discovered the old patterns, which had been stored away in a loft, and as a result he had an excellent season's business, through making silk articles of that particular pattern.

MR. F. BENNETT-GOLDNEY, M.P., thought that the Chairman's and the author's remarks were absolutely true, that it was possible to produce at the present time in this country silks and velvets as beautiful as any which had been produced in any other part of Europe. He was glad to think that the Chairman had paid such a kindly tribute to the author's father, who did so much to restore the silk industry in England when it was all but driven out for good. It said a great deal for the strength of the industry that such beautiful silks and velvets as were exhibited on the walls of the theatre were still produced in England—he was almost going to say under a Radical Government, but he must not introduce politics. At the same time he thought it behoved everybody interested in the silk industry to think out things very closely for themselves, so that in the future they might find not only the silk but other industries receiving that kind of protection under which it throve so well. He thought the nation was to be congratulated upon the revival of art as applied to the domestic decoration of the present day. A great debt of gratitude was due to those who distributed the goods as well as to the manufacturers, and the author and other manufacturers were among the first to recognise that obligation. He was delighted to see present a gentleman who had done a very great deal to train the rich purchaser, both on this side of the Atlantic and on the other, in the right direction in connection with the buying of beautiful fabrics and in choosing beautiful colours for their decorations; he referred to Mr. Allom, whose name he believed would eventually be coupled with names as familiar to people to-day as those of the brothers Adam and other eighteenth century masters. As one who had something to do fairly often with the choosing of fabrics, he was very pleased to notice, as the years rolled on, that even in the great emporiums one or two good patterns were now and then found. If he went to Tottenham Court Road, he was now always able to find one good pattern in a shop, and if he inquired where it came from he was always told that it was of English manufacture, and the work of Messrs. Warner. There was one piece of advice he would like to give, which was of even more importance, he thought, than anything that could be said to the manufacturer and distributor. If the rich purchasers of to-day would insist, as many of them in England were doing, upon having English silks, English velvets, and English woven goods, it would not only increase the commerce of the country and its prosperity, but it would enable the manufacturers to hold their own against any foreign competition, wherever it might come from. Really the purchaser was the crux of the problem, and it was therefore a very pleasing thing to notice that so many ladies were present at the meeting. If English ladies only knew that English silks wore a great deal better than foreign silks, and that English silks were now even exported to Paris for the best millinery and the best dresses, they would know that they were in the fashion if they bought English silks, and at the same time they would be doing a patriotic service.

MR. J. H. MURGATROYD (Halifax) desired to add his testimony to the very accurate details given by the author as to the business of silk spinning by machinery, the particular trade which he represented. The service Mr. Warner had rendered to the industry by reading his present paper was only one of the many efforts he had made in the interests of the silk industry of Great Britain and Ireland; and on behalf of the silk-spinning industry he thanked him very much indeed for his work on their behalf.

MR. A. J. SOLLY (Congleton), as a silk spinner, thanked the author for the masterly and interesting manner in which he had described not only the practical but the artistic part of the silk industry. He was glad to say that the silk-spinning trade had not lost ground. Personally, he was the last survivor of a firm started by his grandfather in 1783 for throwing and weaving silk, and latterly silk spinning, and he was glad to say that during the last year his firm had spun more silk than in any year in its previous history. Nevertheless, that did not represent the position which he considered the industry ought to occupy. It only meant that British silk spinners had the leavings of a demand which in the past year was greater than ever before. They now held the same position as a silk-spinning industry that they held thirty years ago, but during that time—it might be under Protection, and it certainly was owing to cheaper labour—an enormous industry had grown up abroad, which was at least ten or twenty times the size of the industry in this country. He was not one of those who thought that the struggles of those connected with the silk industry in this country would be lessened in the future. Even now they were faced with very serious competition from Japan, which had already beaten them in some neutral markets, such as India and the Far East; and without being pessimistic he thought British manufacturers would have a great struggle with the Japanese in the future, perhaps far greater than they had had with the Continental spinners in the past. To face that it would be necessary to rely not on the artificial help but the friendly help of the Government, and the good sense and friendly help of the workpeople and the trades unions. Greater freedom was required from unintelligent legislation, and more freedom was required in connection with labour. He did not think any Government, either Conservative or Radical, had sufficiently

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understood the processes of manufacture for which it had legislated, and he very greatly regretted that Sir William Priestly, one of the Vice-Presidents of the Silk Association, had not yet been able to secure the object of his ambition in going into Parliament, namely, the foundation of a Ministry of Commerce. The present Insurance Act would tell very hardly on a trade like the silk industry, which depended so much on female labour, and this was another argument in support of his contention that more intelligent legislation was required on questions connected with the trade of the country. He pleaded also for greater intelligence on the part of their customers, the ladies and the public in general. He hoped that those who bought silks in this country would lose the prejudice, which still lingered to a certain extent, in favour of French or Italian silks; and he also hoped that when they paid for silk they would see they got it, and would not be put off with material made of inflammable wood-pulp or with a silk dress made of tin. He hoped that there was a bright future in store for the silk industry, but he could not share the view of some gentlemen who had lately spoken in public, that its condition was at present as rosy or as satisfactory as had been stated. A speaker had recently been reported as saying that the silk trade of Macclesfield was booming as never before. Personally, he lived in the next town to Macclesfield, and knew that during the past six months the weaving trade in Macclesfield had been worse than at any time during the past ten years; and at the present moment not one in ten of the manufacturers knew what would happen in the next few months, owing to the present unfortunate labour troubles and the rumours of war, which were very disastrous to a trade connected with a luxury.

Mr. Charles C. Allom thought that the paper was one of immense value, and that it would serve as a work of reference in the future to all connected with the silk industry in this country. Apart from the Chairman's illuminating remarks, he thought Mr. Bennett-Goldney had referred to one of the most important points connected with the question, namely, the education of their patrons. There was no better customer for the silk industry than a lady, but her custom depended upon whether the goods were new and of the latest type of fashion. It was not much good preparing goods of wonderful artistic merit if the ladies of the present day simply went in for materials that were apparently quite new. He was afraid that ladies required to learn more of the artistic value of silk goods; when they did so a greater encouragement would be given to the art side of the industry. So far as the actual technical side went, there was not the smallest doubt that this country stood second to none in the world, but it was a most remarkable thing that hardly any of the designs were the direct outcome of British art. The author largely owed his success to the fact that he knew what the taste of the well-to-do public was, and the patterns which were most popular related mainly to styles of the past. Mr. Warner had, with great power of selection, shown specimens at the meeting of the wonderful work of the past generation. There was a silk shown which passed as Adams' silk, but which certainly was never known in the days of the Adams; and there were many others that had their origin in Mr. Morris's studio; but on looking at all the specimens he thought that Mr. Morris could not hold his place amongst the many other beautiful patterns that were exhibited.

Mr. W. R. Fox said it was in recognition of the great services which the author, and his father before him, had rendered to the industry that he was elected straight on to the Court of the Weavers' Company, an honour he was sure all would agree in thinking was thoroughly deserved.

The Chairman remarked that it was entirely owing to the energy of the author that when the British Section at the Brussels Exhibition was destroyed by fire, it was immediately rebuilt; as a matter of fact, Mr. Warner began to rebuild the section the very next morning.

A resolution of thanks to Mr. Warner for his paper was then carried unanimously.

Mr. Frank Warner, in reply, thanked the Chairman for the very kind remarks he had made with regard to himself, but even more he desired sincerely to thank him for his kind references to his father. He assured the Chairman that the family felt that their father should ever be recognised, and the kind words which had been spoken by the Chairman would have a new measure of happiness for himself and his family. It would have given some spice and flavour to the proceedings if his paper had been criticised, but as it had not it was only possible for him to thank all the speakers for the many kind things they had said, not only in connection with his own private work, but also the work of the British Silk Association. In conclusion, he wished to express the hope that all present would as heartily support the forthcoming Exhibition as they had supported him that evening.

JAPANESE VEGETABLE ISINGLASS.

Japanese isinglass, or agar-agar, is made from six kinds of seaweed, the best qualities of which are found on the coasts of the Provinces of Izu, Tosa, and Sado, and are known as Izu, Nanbu, Misaki, Onikusa, Egokusa, and Hirakusa. At the close of summer the seaweed is bought up by wholesale dealers in Osaka, and stored there in "go-downs" until sold to the manufacturers. The manufacture of vegetable isinglass, as its Japanese name, "Kanten" (cold climate), would imply, can take place only in the autumn and winter, as warmth and rain spoil the product. The process is simple, and the utensils employed are primitive. The factories are situated at Ibaraki, in the mountains between Osaka and Kyoto, and at Nishinomiya, between Osaka and Kobe. The process of manufacture, according to the United

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States Consul at Kobe, may be described as follows:—The seaweed is first crushed, each kind separately, to remove shells or other adhering matter, and then washed clean with water. The washed seaweed is placed on a mat and dried until its colour becomes white by the action of the sun, frost, and dew. This operation takes place during September and October, and when bleached the weight of the seaweed is decreased nearly one half. After bleaching, the six kinds of seaweed—in the proportion of Izu, 4; Egokusa, 4; Misaki, 3; Hirakusa, 3; Nanbu, 4; and Onikusa, 2—are all put together in a boiler and cooked for about fourteen hours, until they have become soluble. The liquid is then strained through a sack and a box with a bamboo sieve on one side, from which it runs into a container. From the container the liquid is ladled into trays about three and a half feet long and three inches deep. After remaining in the trays about twelve hours, these are placed on a low stand, and the isinglass is cut into strips three inches wide and fourteen inches long, with a knife and ruler. These strips are then put into a long closed wooden box (the ends of which are three inches square, one end being open and one filled in with a wire sieve) and pushed through the sieve end in the form of long fine strips. The isinglass is then placed on a low stand, which is covered with a clean mat, and dried in the sun during the day and frozen during the night for two or three weeks during the months of January and February, being watered at midnight. The quality of the isinglass depends upon the weather during this time, the best being made when it is clear and cold, the poorest when it is warm and rainy. When the isinglass is bleached sufficiently it is compressed and packed in Japanese matting, tied with straw rope. The very best quality is all exported to China, the No. 1 quality that is shipped to America being equal to the No. 2 that goes to China.

THE PREPARATION OF WEST-PHALIAN HAMS.

Westphalian ham, more or less famous throughout the world as a German table delicacy, is given its peculiar piquant taste by the use of juniper berries in smoking the meat. The juniper shrub is indigenous to north-western Germany, and so plentiful, especially in Westphalia, that to its presence is due the growth, during the past centuries, of two principal industries, the distillation of gin and the preparation of hams. According to the most authoritative information obtainable, Westphalian hams are prepared in the following manner. The carcasses are cut in such a way as to retain the whole ham bone, together with the hip. The hams are then rubbed thoroughly with a solution of one hundred pounds of salt to one pound of saltpetre, when they are placed on cement floors, or in vats, and thickly covered with salt. They are allowed to lie in this solution for a period of two weeks, and then placed in another receptacle with a 22 per cent. solution of brine. They remain in this solution for a period of eighteen days, their position being changed from day to day so that the hams at the bottom are brought to the top. At the expiration of eighteen days they are removed from the brine and packed one upon the other in a cool dry cellar for four weeks, during which time they are supposed to ripen, that is, to become tender and take on colour. They are then cleaned with a stiff brush in lukewarm water and allowed to soak in fresh water for twelve hours. They are then ready for the smoke-house. The smoke-houses consist sometimes of two, and sometimes of three stories, the fire being kindled in the lowest, and the meat hung in the second and third, to which the smoke ascends through holes in the flooring. Westphalian hams are invariably smoked over a bright fire made of beechwood only, except that juniper twigs and berries are constantly thrown on the fire. Beechwood sawdust is thrown over the fire in case it becomes too strong. The smoking process requires on an average about eight days.

THE POTATO-FLOUR INDUSTRY OF GERMANY.

The great bulk of the so-called potato flour (kartoffelmehl) that is sold retail in Germany for cooking purposes, is simply finely ground and sifted potato starch. There is, however, a flour obtained by grinding and bolting dried potatoes, that is a comparatively new product. In 1901, when the potato crop of the country reached the enormous total of 53 million tons, efforts were made to discover practical and economical methods of preserving the potatoes, so that the surplus could be stored and utilised in supplying future demands. Prizes were offered, and a number of processes were submitted, in the more important of which the potatoes are treated by steam, forming what are called "kartoffelflocken," or potato flakes, which can be used for cattle food, for distilling alcohol, for making starch, and for other purposes for which potatoes are used, or they can be ground and bolted for human consumption. In the Tätosin process for the production of flakes, the raw potatoes are washed in a washing machine commonly used in distilleries or starch factories, and then conveyed to a steamer erected over the drying apparatus, where they are cooked by means of low-pressure steam, as if the potatoes were to be used for cattle food. The American Consul at Berlin states that the drying apparatus proper consists of two smooth hollow cast-iron revolving drums about 4 feet long and 2 feet in diameter, each with a clearance of about ·039 inch. The drums are supported upon a cast-iron framework, on the top of which there is an iron hopper fitted at the bottom with emasculators or crushers. The drums are heated by steam led through a pipe passing through their axes. The interiors of the drums are ridged longitudinally. Condensed water is taken from the drums by small pipes, and returned

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to the boilers. The potatoes, after being steamed, are allowed to fall into the hoppers and through the emasculators, where they are reduced to pulp, and in this shape are forced on to the drying drum. The drums turn in opposite directions at five revolutions a minute. The heat drives off the moisture of the potato pulp, leaving a firm mass that is scraped off by means of knives set parallel to the main axes of the drums. The dried mass falls into a spiral transporter fitted with revolving arms, where it is broken into flakes and conveyed to the packing room. In other processes of preserving potatoes used in Germany, the tubers are cut into discs or small pieces and dried by hot air. The method described above is, however, that most in use. At present there are four hundred and thirty-six plants established in Germany for drying potatoes, with an estimated production annually of about 135,000 tons. In the production of ground potato flour the potato flakes are ground and bolted. There are but few concerns that manufacture the flour, each having its own process. The flour is a yellowish-white product, rich in carbo-hydrates. According to experiments made by the "Institut für Gärungs-Gewerbe" in Berlin, the principal constituents of the flour are—water 10·69 per cent., protein 6·59 per cent., fatty substances 0·23 per. cent., non-nitrogenous substances 78·73 per cent., raw fibre 1·18 per cent., and ashes 2·58 per cent. The flour is used principally by bakers for adding to rye and wheat flour in making bread. The proportion for wheat bread is 5 to 10 per cent. of the ground potato flour, and for rye bread the amount can be increased to 15 per cent. It is claimed that the addition of the ground potato flour to the rye or wheat flour, gives the bread a good flavour, makes it more digestible, and keeps it fresh for a comparatively long time. Ground potato flour in Germany is known to the trade as "Walzmehl," "Kartoffel Walzmehl," and "Fiddichower Walzmehl."

EMPIRE NOTES.

British Naturalisation.—In the King's Speech it is stated that a Bill will be introduced to give effect to the unanimous recommendation by the last Imperial Conference, for the amendment and consolidation of the law relating to British nationality. The draft of the proposed measure has been sent by the Colonial Office to the Governments of the Oversea Dominions. The main provisions are that an alien may apply for naturalisation as a British subject if he has lived for five years continuously within His Majesty's territory, is a person of good character, possesses an adequate knowledge of the English language, or of any other language recognised in any dominion as on an equality with English, and is prepared to take the oath of allegiance. The proposed law, however, will only become operative after the local legislatures of the self-governing dominions have adopted it. The ordinary right to be called a British subject applies to everyone born within His Majesty's allegiance, or who, at birth, was the child of a British subject, on the paternal side, or was born on a British ship whether in foreign or territorial waters.

The Australian Commonwealth Bureau of Statistics.—An interesting statement has been made by the Commonwealth Statistician in regard to labour statistics. He says: "Considerable progress has now been made in connection with the organisation of the labour and industrial branch of the Commonwealth Bureau of Census and Statistics. This branch is being established with a view to supplying prompt and accurate information as to wages, hours of labour, conditions of employment, prices, unemployment, cost of production, and numerous other matters peculiarly of labour and industrial interest. Agents of the new labour branch have now been appointed in more important industrial centres of the Commonwealth, and the cordial support and co-operation of a majority of the trades unions and other labour organisations have been obtained. Steps are also being taken to obtain much more complete information from manufacturers and others than has hitherto been available, and the systematic collection of returns as to retail prices throughout the Commonwealth is now being initiated. Such questions as unemployment, strikes and lockouts, the natural wealth and its distribution, the cost of living, house rent, and the working of the various laws more directly affecting labour, are receiving special attention. A considerable amount of organising work yet remains to be carried out, but it is hoped to complete the main features of the scheme during the current year. Individual persons, companies, and organisations furnishing returns in connection with the scheme are protected by the fact that all the information is treated as strictly confidential, and the particulars given will be grouped together for publication in general form for allied trades." The question of publishing the returns in a suitable periodical is under consideration. The system instituted should prove of great utility to manufacturers and employers of labour as well as to employees.

A Valuable Queensland Fruit.—Among the indigenous fruits of Queensland, the paw-paw is rapidly gaining popularity. It is a species of tree melon, and the flavour is delightfully refreshing, though quite different from the melons known in this country. On being cut, the rind is found to be thinner than that of the ordinary tree melon. The flesh is either pink or yellow, and in the centre are many small round black seeds. It rivals in flavour the durian and the mangosteen of other and tropical countries. The leaf is said to have the effect of causing tough beef-steak or other meat to become tender, when wrapped in it. The paw-paw has for many years been the source of the pepsin used in pepsin tablets and pepsin gum. Real pepsin is obtained from the stomachs

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of ruminant animals, while the product of the paw-paw is a papoid compound possessing practically the same qualities as pepsin. The substance is obtained from the fruit just before it reaches maturity, when four longitudinal cuts are made through the skin. When this is done there oozes out a quantity of white juice resembling milk-weed in appearance. After this liquid has been collected in receptacles, it is distilled, and the residue, a white powder, remains. An eminent Queensland physician has discovered that an ointment made from this fruit possesses medicinal healing qualities. It has proved valuable as a cure for burns, scalds, and other injuries of the skin.

Australia's Trade with India.—Australia has in India a most profitable oversea market for some of the natural products of the country. Trade has been encouraged and followed up assiduously for a number of years, and at the present time business is on a sound footing with every prospect of further development. Australia has by far the largest share in the supply of horses for India. Out of a total of 7,552 horses, valued at £220,166, imported into India during 1910, 6,179, valued at £181,491, came from Australia. Most of the rest (881, valued at £19,041) came from Asiatic Turkey, by way of ports in the Red Sea and Persian Gulf; 67, valued at £1,340, came from New Zealand; the remainder (365) from Great Britain and other countries. The exports of timber from Australia to India were valued at 328,387, consisting mainly of railway sleepers, valued at £289,007. Most of this trade is done by West Australia, which is stated to be pushing the business very energetically. The value of the fruits and vegetables imported from Australia was £5,520, and of grain and pulse, £5,171; of coal, £27,842; of wool and woollen goods, £22,520; and of tallow, 5,210. During the year Australia purchased from India a considerable quantity of jute and jute bags.

Canadian Mining.—The Department of Mines at Ottawa has recently issued a report, in which it is shown that the mineral production of Canada for the year 1910 was 16 per cent. above that of 1909, and was the largest increase in any one year since 1886, the first year in which statistics of the whole of Canada were collected by that department. The progress that has been made in the interval may be judged from the fact that, while in 1886 the value of the mineral production was 10,221,225 dollars, the value in 1901 was 106,823,623 dollars. From 1886 to 1896 the returns showed an increase of over 100 per cent., but in the latter year the Yukon district began to contribute largely to the gold production, so that during the next five years a further increase of 200 per cent. above the returns of 1896 was recorded. The next three years indicated a slight falling off, but from 1904 the production rapidly increased to the present high standard. The production of metalliferous products in 1910 was valued at 49,428,873 dollars, being 46 per cent. of the total mineral output, and an increase in value over the previous year of 5,282,032 dollars, or nearly 12 per cent. The value of non-metalliferous products (excluding structural material and clay) in 1910 was 37,757,158 dollars, being 35 per cent. of the total mineral output, and an increase of 6,615,907 dollars, or 21 per cent. in value over 1909. The value of production of clay, lime, stone, and other structural materials in 1910 was 19,627,592 dollars, or 18 per cent. of the total production, and an increase of 3,094,243 dollars over 1909. Amongst the most important minerals giving the above returns, coal occupies first place, contributing about 29 per cent., followed by silver, which yielded 16 per cent. of the total production.

Canada's Telegraphs.—The telegraph systems of Canada are worked almost exclusively by public corporations, and the central Government operates only a small percentage. In point of fact, the Government's mileage is only 150¼, against 155,000 owned and worked by the corporations. The Government lines are not competitive with the others; they are run through sparsely settled districts, and are not intended as revenue earners, their object being to supply cheap and efficient communication to the settlers who are developing new lands for agricultural and commercial enterprise. When a railway enters one of these districts, the Government either transfers or sells its line. In cases where messages have to pass over Government and other lines, special arrangements are made to reduce to a minimum the double cost of the double transmission, and the harmonious co-operation between the Government and the railways enables the settlers, who are on the outskirts of Canadian civilisation, to secure, at practically minimum rates, inter-communication with the centres of commerce. An interesting fact in connection with Canada's telegraph systems is that no charge is made for names and addresses. By this means, full and complete direction is obtained.

The Reconstruction of the Welland Canal.—An important announcement has been made at Ottawa to the effect that the Government has decided to reconstruct the Welland Canal. The depth of this waterway is to be increased to 22 feet, thus giving a depth sufficient for navigation from the head of Lake Superior to within 100 miles of Montreal. When this alteration is complete it will enable Canada to compete successfully with the new Erie Canal on which the United States is spending some hundred million dollars. The approximate cost of the undertaking to the Canadian Government will be somewhere in the neighbourhood of £6,000,000 sterling. The chief object in deepening the Canal is to facilitate the east to west traffic in grain and merchandise. It will also considerably cheapen the cost of transportation of wheat from the western plains to Montreal. It is also proposed to deepen and widen the last 100 miles, so that it will be possible to bring grain direct from

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the Great Lake ports right into Montreal. The latter project, however, is not contemplated immediately. Transportation experts have advised the Government that the reconstruction of the Welland Canal is more important than the Georgian Bay Canal scheme. Work will be commenced on the Welland Canal during this year.

South Africa and Immigration.—Much hostile criticism has been levelled at the Union Government on account of its apparent apathy on the question of immigration. Critics are of the opinion that South Africa should inaugurate a policy on similar lines to that of Canada or Australia. But all who are acquainted with South Africa must realise that a general indiscriminate policy would not be to the best interests of that country. Colonel Leuchars, Minister of Commerce and Industries, in a recent speech on the subject, said that the conditions in South Africa were so utterly different from those of Canada or Australia, that the same conditions of immigration would be impossible in that country. Dealing, however, with the need in South Africa for white people, he said that since the last census the Government had been most anxious about the small increase of the white population and the large increase in the coloured. But he wanted to encourage the right class of men, with a certain amount of capital, for which purpose a Land Settlement Bill would be introduced giving the Government similar powers to that of the Natal Act. This measure, since the delivery of Colonel Leuchars' speech, has been adopted by the South African Parliament, and a loan of five millions is to be raised in order to give it effect.

CORRESPONDENCE.

THE TRAINING OF CRAFTSMEN, DESIGNERS, AND TEACHERS OF DESIGN.

With reference to the article on the above subject in the *Journal* of the 16th inst., it appears to me that several points are mentioned which require elucidation. The new Board of Education regulations are evidently meant, as the article suggests, to check the flowing tide of students, artists and craftsmen who are taking to the teaching profession as a means of livelihood; and also to render the training of the teacher such as to ensure that only keen and able students shall survive the tests.

Whether the new curriculum is a good one can only be judged by experience; that it is a stiff one, can hardly be disputed. One can only ask whether the art teacher's salary is to be raised proportionately with the status of the teacher's qualifications? The present condition of the art teaching profession is economically wrong. There are many skilled and able artists and craftsmen teaching at an absurdly inadequate wage, because a market for modern art and craft work hardly exists, and they have to accept a scale of remuneration which is in no way commensurate with their ability. Educational authorities have reaped the benefit of this economic condition. They are well aware that for any decent posts, however low the salary, a crowd of excellent candidates will apply. The art teaching profession at present consists of free lances and orthodoxly trained art teachers, and it would be interesting to know the opinion of educational authorities as to which class the more efficiently fills the needs of art education. It would seem that they consider that a teacher should be trained along fixed lines; that art—that is, beauty, fitness, design, construction and expression—can only be developed by the student of pedagogy and the historic styles, the "great reality" being that no amount of excellent teaching will produce vitality. The only way to put life into art is to create a demand for that which is right by doing that which is vital, that which is *needed;* and apprenticing the beginners to the "master-builders" who are responsible for such public work. We have been too content to subsidise our educational institutions, when what is really needed to-day is the subsidising of organised work. To *do* that which is vital has ever been the only way of gaining true knowledge. The whole world of art to-day suffers from one thing only—the lack of opportunity. Subsidise the right opportunities, and systems of training may take care of themselves. I, for one, would cry a truce to all theories. Let us have work.

I might ask, by the way, how, under the new regulations, will teachers be found to fill the numerous posts for elementary art teaching? Will the *fully* qualified teachers be expected to take such posts at the present rate of salary? With respect to the younger generation of craftsmen who are being launched on the world, I have always understood, from those in close connection with our technical institutions, that the trouble is that their general taste and desire to do the best work is far too high for the labour market requirements, and it generally results in the youth degenerating into something little better than the ordinary trade worker.

There are many other points which I am tempted to question in relation to our educational systems, but the bedrock of our difficulties is the need of vital work, on a large scale.

DUDLEY HEATH.

GENERAL NOTES.

THE CONSUMPTION OF MEAT IN ITALY.—The consumption of meat in Italy has risen, during the last seven years, nearly fifty per cent.—that is to say, from twenty-one kilograms per head of the population in 1903, to thirty kilograms per

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head in 1910. The increased demand for meat, on the one hand, and the falling off in the number of cattle raised, are no doubt the principal reasons for the high prices of meat in Italy at the present time.

THE GROWTH OF CANADIAN TRADE. — The monthly reports of the Department of Trade and Commerce of Canada are amongst the most exhaustive of their kind published by any Government. Although they consist almost entirely of statistical tables, they illustrate very strikingly the rapid growth of the trade of the Dominion. The exports of coal do not increase very rapidly, being only 1,826,339 tons in 1910, but copper shows a big rise in the last twenty years from 10,994,498 lbs. in 1891 to 57,536,116 lbs. in 1910. The export of salted fish varies somewhat, but at 773,401 cwts. is much what it was in the 'nineties. The export of canned lobsters is less than it was ten years ago, but canned salmon amounted to 34,656,097 lbs. last year. The export of pines has fallen off very considerably, and of spruce and other deals to some extent, but planks and boards show increases. The value of furs, dressed and undressed, amounts this year to $4,277,744. The export of bacon and hams, and butter, and in a less degree cheese, show remarkable decreases. In 1903 the export of hams amounted to 141,956,909 lbs., last year to 58,874,525; of butter, taking the same year, 34,128,944 lbs., but last year only 4,615,380; of cheese, in 1903, 229,099,925 lbs., last year only 180,859,886. The export of apples has increased considerably, and while in 1900 the export of these was only 16,844,650 bushels, last year it was 49,741,350 bushels. Perhaps the most remarkable increase of all is in wood-pulp. The figures only go back to 1890, when the total value of wood-pulp exported was $168,180, last year it was $5,204,597.

THE PITH-GRASS INDUSTRY OF FORMOSA.—In Formosa pith grass is found in the prefectures of Shinchiku, Toyen, Taihoku, Giran, Taito, Karenko, Ako, and Taichu. The total production annually in these districts is stated to be between 225,000 and 300,000 pounds, but actually it amounts to a little less than that. The districts where the grass is grown are situated in the savage territory, hence production is not only limited, but gathering the grass is a hazardous occupation. Formosa pith grass is divided into two kinds, high and low hill products, which are again subdivided into seven grades, according to quality. There are twenty pith-paper manufacturers in the town of Shinchiku, and one or two in Daitotei. The former town has naturally enjoyed a monopoly of the trade. Moreover, because of its nearness to the district of production, it has greater advantage in selecting materials than other districts. This condition assisted the growth of the trade, and gave a living to hundreds of native workmen. Formerly the pith-paper sent to Japan was used mostly for artificial flowers, but recently it has been employed in the manufacture of picture cards. In foreign countries, especially in France, it is utilised in fashioning hats and ladies' bonnets. In America it is used in artificial-flower making. Chinese girls are adepts in flower making, and produce such artistic creations that the practised eye cannot detect the artificiality. Lately the pith-paper market has been much disturbed by attempts on the part of a company to control the local production, and by the introduction of an imitation paper. The total export of pith grass from Formosa in 1910 was 30,000 pounds.

COTTON-GROWING IN THE DOMINICAN REPUBLIC. —Although the cultivation of cotton in Santo Domingo is a new industry, the fibre is already assuming importance as a factor of agricultural wealth and as an article of export. About three years ago seed imported from the United States was distributed by the Government among the small planters of the provinces of Monte Cristi and Santiago, and the success attained recently led many of the more important agriculturists to abandon other products for this more remunerative one. This was aided also by failure in the tobacco crop. The Government continues active in stimulating the cultivation of cotton by the distribution of seed, literature dealing with the subject, and personal demonstration when practicable. Indications point to the district known as the "Cibas," particularly in the provinces of Monte Cristi and Santiago, as that most adapted to cotton production. Here there is a geological composition best suited to the cultivation of cotton. Rainfall in the northern part of this district is not very plentiful, and it is thought that this will eventually necessitate moving towards the east. The variety of cotton produced is sea-island mixed with an indigenous kind of seed. Gins are in operation in Monte Cristi and Puerto Plata.

THE PRODUCTION OF ALCOHOL FROM HENEQUEN WASTE.—An invention, which will be of great interest to the planters of henequen or sisal hemp in particular, as well as of practical utility to the world at large, has lately been patented by a native of Tabasco, Mexico, but resident for some years in Yucatan, for utilising the residue of the maguey, after the fibre has been taken, for the manufacture of alcohol. In the process of extracting the fibre the "flesh" of the leaf is scraped off by machinery, and this, with the exception of a small portion used in the manufacture of packing-paper, has been, heretofore, simply thrown on the rubbish heap. It has been found, after years of experiment, that this waste, together with the juice which escapes during extraction of the fibre, will produce, according to the American Consul at Tapachula, a good, merchantable alcohol. The raw material is placed in tanks with water and allowed to ferment for two days, after which it passes into a specially-arranged still. For some time the spirit produced was unsatisfactory, both as to taste and colour, but the late tests, made in the presence of some three hundred of the most prominent business men of Yucatan,

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were said to be entirely creditable to the inventor. With the immense territory devoted to the culture of the henequen plant in the peninsula of Yucatan, and the yearly increase in the number of acres planted in that State, there should, it is said, be a practically unlimited supply of the raw material. At the same time the multiplicity of uses to which alcohol is now put ensures a constant demand.

The Production of White Arsenic in Spain.—In north-western Spain there are several mines of arsenic pyrites from which white arsenic is now being manufactured. The principal mine, the San José, is situated near Castro del Rey, where the following method of manufacturing the arsenic is employed. The first operation after the pyrites are mined is the thorough pulverization of the ore in a crushing machine, which reduces the lumps of mineral to the size of one-fifth of a cubic inch. It is then passed into the furnaces. The latter consist of a revolving cylinder twenty-nine feet in length and five feet in diameter, whose interior is protected by refractory bricks laid in the form of a spiral, so that the mineral may pass slowly along its entire length and be continually exposed to the action of the heat. One of the ends of the cylinder fits into the fire pit and the other end into a condensing chamber, which, in turn, is connected with a series of ten other chambers arranged in zigzag fashion, which completes the required system of accumulation. During the operation the gases given off pass through the series of chambers, each of which is divided into various compartments, and are thereby condensed, depositing upon the walls of the compartments the white powdery substance called arsenic floss. This article is then gathered from the various chambers, but in its actual state is not marketable on account of its colour, which is dark grey. In order to whiten and refine the powder it is necessary to subject it to another treatment, the result of which is pure white arsenic. This is then pulverized, sifted, and packed for exportation.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

February 28.—H. A. Roberts, M.A., Secretary of the Cambridge University Appointments Board, "Education in Science as a Preparation for Industrial Work." Principal Sir Henry A. Miers, M.A., D.Sc., F.R.S., will preside.

March 6.—T. Thorne Baker, "Some Modern Problems of Illumination: The Measurement and Comparison of Light Sources." James Swinburne, F.R.S., will preside.

March 13.—Professor Ernest A. Gardner, M.A., "Greek Sculpture."

March 20.—F. Martin Duncan, "The Work of the Marine Biological Association." P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., will preside.

March 27.—Theodore E. Salvesen, "The Whaling Industry of To-day."

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

April 25.—Sir John O. Miller, K.C.S.I., "The Central Provinces."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

March 26.—Leonard Lovegrove, "British North Borneo."

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Luther Hooper, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

Syllabus.

Lecture I.—February 26.—*Primitive Looms and Spindles: Prehistoric, Ancient, and Modern.*—The loom and spindle almost universal—Modern spinning and weaving machinery all constructed on ancient principles—Traces of prehistoric spinning and weaving—Simplicity of primitive tools and appliances—The simple textures of prehistoric cloth—The simplest loom and its essential parts—Modern and prehistoric webs compared—The spindle of all time—Advantages of *distaff and spindle* spinning—Modern distaff spinners—Spinning wheels—Peculiarity of primitive and ancient European looms—Greek and Egyptian methods of weaving—Egyptian, Persian, Roman, Brussels, and modern French and English tapestries.

Lecture II.—March 4.—*The Handloom for Automatic Weaving, Plain and Ornamental, and the Modern Spindle.*—Leonardo da Vinci's sketch of the spinning wheel *flier* and *bobbin* attachment—Its general adoption in Europe for hand spinning—Varieties of the motion developed—Inventors of spinning machinery—Hargreave's *Jenny*, Arkwright's *Waterframe*, Crompton's *Mule*, and others—Weaving in ancient China—Horizontal looms—Indian looms—Old English and other looms for silk weaving—Chinese silk loom—Invention of satin weaving—Looms for weaving small designs—Double *harness* weaving—Long- and short-eyed *leashes*—Chinese *draw-loom*—The *comber board*, its great importance—The *pulley box*—The tail of the loom—The *simple*—The *tie-up* of the design—The *divided* comber board and other arrangements for *tissue* weaving—European draw-looms—Examples of draw-loom woven textiles of various periods.

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Lecture III.—March 11.—*The Modern Loom for Plain and Ornamental Weaving and its Future Development.*—Eighteenth century inventions compared with those of earlier periods—The drawboy—The drawboy machine—The Jacquard machine or *draw-engine*—Kay's *fly shuttle*, its great utility and unexpected value—The first power-looms—Application of steam power to the loom—General adoption of the factory system in textile industries—Comparison of hand and power-looms as regards quality and speed of weaving—The effect of machine weaving on the workers—Defects of the power-loom—Electricity as applied to the loom—The loom of the future.

Noel Heaton, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

Howard Lectures.

Monday evenings, at 8 o'clock :—

Captain H. R. Sankey, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced :—

Charles C. Allom, "The Development of Artistic Skill in the Applied Arts."

Ernest Kilburn Scott, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

E. D. Morel, "British Rule in Nigeria."

Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

George Fletcher, "Technical Education in Ireland."

William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

MEETINGS FOR THE ENSUING WEEK.

Monday, February 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Luther Hooper, "The Loom and Spindle : Past, Present and Future." (Lecture I.—Primitive weaving appliances—Prehistoric, ancient and modern.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. J. Sadler, "Milk Standards."

Post Office Electrical Engineers, Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 5 p.m. Mr. B. O. Anson, "Machine Switching in Telephony."

Surveyors, 12, Great George-street, S.W., 5 p.m. Mr. L. S. Wood, "The Tendency towards Uniformity in Compensation for Agricultural Improvements."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. A. J. Sargent, "The Economic Geography of the Tyne."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 8 p.m. Professor Henry Adams, "Sanitary Building Construction."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. F. C. Eden, "Hopes and Fears for Architecture."

Tuesday, February 27...Sociological, at the Royal Society of Arts, John-st., Adelphi, W.C., 8.15 p.m. Mr. W. T. Layton, "Economic Effects of the Rise in Prices."

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. G. Coker, "Optical Determination of Stress, and some applications to Engineering Problems." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Mr. F. Shelford's paper, "Some Features of the West African Government Railways." 2. Professor John Goodman, "Roller and Ball Bearings," and "The Testing of Anti-Friction Bearing Metals."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Ven. Archdeacon Barnett, "Hong-Kong's part in China's Reform."

Optical Society, in the Rooms of the Chemical Society, Burlington House, W., 8 p.m. Annual Meeting.

Wednesday, February 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. A. Roberts, "Education in Science as a Preparation for Industrial Work."

Geological, Burlington House, W., 8 p.m. 1. Mr. L. J. Wills, "Late Glacial and post-Glacial Changes in the Lower Dee Valley." 2. Messrs. E. B. Bailey and M. Macgregor, "The Glen Orchy Anticline (Argyllshire)."

King's College, Strand, W.C., 5 p.m. (Lectures on Christian Art.) Mr. O. M. Dalton, "Minor Christian Arts."

Imperial Mission, Caxton Hall, Westminster, S.W., 8 p.m. Mr. C. Bright, "Inter-Imperial Cable Communications : A Non-party Question."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Mr. C. E. Wade, "Nicholas Amhurst (1697–1742)."

Thursday, February 29...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Mr. W. H. Winch, "Inductive *versus* Deductive Methods of Teaching : an Experimental Research."

Royal Institution, Albemarle-st, W., 3 p.m. Professor C. Oman, "Wellington's Army." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. H. E. Corke, "Wild Flowers."

Friday, March 1...Fine Art Trade Guild, at the Royal Society of Arts, John-street, Adelphi, W.C., 7 p.m. Lecture on "Engraving."

Royal Institution, Albemarle-street, W., 9 p.m. Dr. W. J. S. Lockyer, "The Total Solar Eclipse in the South Pacific, April, 1911."

African Society, Connaught Rooms, Great Queen-street, W.C., 8 p.m. Major E. A. Stanton, "The Anglo-Egyptian Sudan."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. H. J. F. Gourley, "The Design and Construction of Masonry Dams."

Saturday, March 2...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Molecular Physics." (Lecture II.)

Correction.—Mr. Cecil Thomas desires that the following correction be made in his paper on "Gem Engraving," published in the *Journal* of the 16th inst.:—On p. 364, col. 2, ll. 22, 23, delete the words "once belonging to Lotharius."

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Journal of the Royal Society of Arts.

No. 3,093. VOL. LX.

FRIDAY, MARCH 1, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 4th, 8 p.m. (Cantor Lecture.) LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." (Lecture II.)

WEDNESDAY, MARCH 6th, 8 p.m. (Ordinary Meeting.) T. THORNE BAKER, "Some Modern Problems of Illumination: The Measurement and Comparison of Light Sources." JAMES SWINBURNE, F.R.S., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, February 26th, MR. LUTHER HOOPER delivered the first lecture of his course on "The Loom and Spindle: Past, Present, and Future."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

Wednesday, February 28th, 1912; SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., Principal of the University of London, in the chair.

The following candidates were proposed for election as members of the Society:—

Armstrong, Donald, Lieutenant (U.S. Army), Fort Williams, Maine, U.S.A.

Armstrong, Francis Tuttle, 565, West 113th-street, New York City, New York, U.S.A.

Engineer, Dhunjibhoy Temulji, Grant-road, Bombay, India.

Frere, Miss C. F., 67, Westbourne-terrace, W.

Gaye, William Charles, H.H. the Nizam's Guaranteed State Railway, Secunderabad, Deccan, India.

Mohammad, Professor Khwaja Dil, M.A., Islamia College, Lahore, India.

Napier, Robert West, 26, Bruntsfield-place, Edinburgh.

Pillow, Mrs. Margaret Eleanor, "The Grange," Thorpe-road, Norwich.

Tok, Maung Po, Tharrawaddy, Burma.

Traill, George, "Colwyn," Redington-road, West Heath, Hampstead, N.W.

Worth, Joseph Henry, Tongku, North China.

The following candidates were balloted for and duly elected members of the Society:—

Brown, Frank Percival, A.R.C.A., Halford House, Richmond, Surrey.

Buckley, John, "Arncliffe," Chartfield-avenue, Putney, S.W.

Hayward, Miss Florence, 4937, McPherson-avenue, St. Louis, Missouri, U.S.A.

Higgs, Arthur King, 95, High-street, Cheltenham.

Jhalawar, His Highness the Raj Rana of (Sir Bhawani Singh, K.C.S.I.), Kothi-gardens, Jhalrapatan, Rajputana, India.

Wakefield, Captain Edward William, Strickland-gate House, Kendal, Westmoreland.

The paper read was—

EDUCATION IN SCIENCE AS A PREPARATION FOR INDUSTRIAL WORK.

By H. A. ROBERTS, M.A.,

Secretary to the University of Cambridge Appointments Board.

I have had some difficulty in choosing a name for this paper. There has been much recent discussion of this and kindred matters, but this discussion has been confined, as a rule, to the question of the training and employment of industrial chemists or of engineers. I desire to survey a somewhat wider field; to inquire into the attitude of the industrial world to the educated man; into the question of the supply of persons of a high rank of intelligence; and into the effect of higher education, and particularly of education in science, on a young man's fitness for industrial purposes.

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Incidentally, questions relating to the industrial chemist and the engineer, and to the condition of their earlier employment, will appear. The question, too, of how far academic ability is an earnest of success in practical life will inevitably be raised.

The class of students under consideration is of a somewhat high order of ability, and the question at once arises as to the numbers in which they are produced. Are there enough of them? Every practical man and every professor will tell you, No. Not enough, at all events, to meet the almost overwhelming demands of a great industrial community of the present day. Can we, then, increase the supply by means, for example, of the scholarship ladder? A Mendelian with whom I discussed this question was inclined to pessimism. "We are all such mongrels now," he said; and he was inclined to believe that society as a whole, in this country, had been so shaken, sifted, and sorted, that there was little chance of new combinations coming to light. He thought, however, that it was possible that some good old stocks, which had sunk to apparent decay in the devitalising circumstances of town life, might be really unimpaired, and under proper conditions might again be productive of ability. If that is so, the future becomes immensely more hopeful. The determination of this and kindred questions is urgent, and it is the imperative duty of students of genetics to endeavour to give us a clear lead.

Whatever be the truth, it is now demonstrated that there does exist a certain reserve of ability in those strata of society in which economic opportunity has as yet been scarce. Such evidence as is available at present suggests that this reserve is not nearly so great as popular imagination figures it. For example, the profitable expenditure of scholarship money, whether from old endowments or from the rates, undoubtedly has a limit which we appear to have reached and even overstepped. Experience may improve the methods of selection, and so increase the supply of good material. But it is important to administer the available funds wisely, and to give the really able a full measure of help, at the expense of those whose training will be less profitable to the community. I would further plead that a good store of physical energy is of the utmost importance for students of this type; the strain they have to undergo is heavy. How far the higher equipment should be carried is, even from the point of view of the student, a nice question. The years spent in attempting to acquire technical knowledge which is beyond the real limit of his ability may be positively harmful to him. For it must be remembered that on rather lower levels it is easier to achieve a relative success. To aim high is to incur risks; they are not *always* worth taking.

I will illustrate my meaning by some remarks made by a man of business who is also a man of science. He was discussing with me the question of employing the university-trained chemist. "It," said he, "I take a boy from a technical school, he is mere hands to me. If he is unsatisfactory or untrustworthy, I can dismiss him, and no one else will have him for similar purposes. If he is a good boy, he will finally arrive at a stipend not very different from that at which a university man would expect to start, and it will satisfy him. If he is a *very* good boy, he may attain £400 or £500 a year, or more, and a position of considerable responsibility. He will not then be so good as a man of better brains and wider training, but he will be a very effective man, all the same."

The explanation of the employment of the graduate in commerce may be put in a very few words. It arises from the tendency to the formation of great organisations and the use of capital in the mass. We have commenced the era of "Trusts" in some form or another. The old family business, small enough to be officered by a few sons and nephews, no longer occupies the whole field. In the great organisations there is room for the educated man, as a servant, it is true, but as a servant profitable both to himself and his employers. A friend of mine was asked by the parent of an able young graduate: "What guarantee have I that if my son comes to you, and is fitted for your purpose, he will receive his deserts?" The answer was: "We have a vast capital invested; we must earn our dividends. To do so we must have the best ability we can command, and it is to our interest to pay well to retain it." Moreover, even in the family businesses, sons and nephews do not among themselves always run to the necessary ability or industry, or there are not enough of them. In any case, it is the undoubted fact that these businesses are tending no longer to breed in, but to ask for new blood. I used to hear the objection: "But how shall I take a man into my business, a stranger to me, and recommended by strangers to me?" I think that by careful and responsible recommendation we are in a fair way to overcome that undoubted difficulty.

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Modern business, moreover, is said to require more imagination, more adaptability, and a wider outlook than was once the case. More than one business man has been critical in my hearing of the traditional view that the only way to become a practical man of affairs is to enter an office early in life, at fifteen or at latest sixteen, and has pointed out that the best years of growth of the mind and of the imagination are thus devoted to routine alone. Is this not too greatly to glorify routine, even business routine, and to regard its attainment as a dark mystery—a *hocus pocus* beyond the grasp of a man of good intelligence at the age of twenty-two? There is another point, too. Many City houses take their employees—I mean those who will, in the course of things, occupy reasonably good positions—from the great London schools at the age of eighteen or nineteen. By so doing they cut out automatically the boys of best ability. There are, I am aware, great difficulties in the way of introducing them at a later stage, but they are difficulties which it is important to overcome.

Anyhow, the tendency to the employment of the more highly educated man is there. In a paper which I read before the British Association in 1904, I pointed out the growing diversity of employment of graduates, and I stated, as the result of examination of the records of a particular college, that in 1865–70, only 3·3 per cent. of graduates adopted a commercial life; in 1885–90 this percentage had risen to 11·5; while of the students matriculating in 1900 and 1901 no fewer than 21 per cent. were destined for commerce on either its administrative or technical side. This drift and its significance was clearly apprehended by the far-sighted men of eminence, in the university or the world of affairs, who gave us our Appointments Board in 1902.

Further, an undoubted change of feeling is taking place towards what must, after all, be the chief concern of an industrial community. I am still sometimes depressed when I tell the head-master of a public school that a favourite pupil has gone into the service of a great commercial house, and he replies, "I hoped he was destined for a more distinguished career"; or when a professional parent tells me that his son will be wasted in business, since (astounding statement) "Anyone can make money." I would earnestly plead for some attention on the part of educators to the ethics of earning an adequate income.

Hazlitt satirically depicts what I may call the nineteenth century attitude:—

"*On the Disadvantages of Intellectual Superiority.*—It is astonishing how soon a fellow without education will learn to cheat. He is impervious to any ray of liberal knowledge: his understanding is 'not pierceable by power of any star,' but it is porous to all sorts of tricks, chicanery, stratagems, and knavery by which anything can be got. . . . I think it is a rule that men in business should not be taught other things. Anyone will be almost sure to make money who has no other idea in his head. A college education or intense study of abstract truth will not enable a man to drive a bargain, to overreach another, or even to guard himself from being overreached. As Shakespeare says that 'to have a good face is the effect of study, but reading and writing come by nature,' so it might be argued that to be a knave is the gift of fortune, but to play the fool to advantage it is necessary to be a learned man. Many a man has been hindered from pushing his fortune in the world by an early cultivation of his moral sense, and has repented of it at leisure during the rest of his life. A shrewd man said of my father, that he would not send a son of his to school to him on any account, for that by teaching him to speak the truth, he would disqualify him from getting his living in the world!"

Contrast this with Lecky's finely expressed view ("History of European Morals," Vol. I. pp. 137–8. Longmans, 1902) that veracity is the special virtue of an industrial nation, and, indeed, constitutes the chief moral superiority of nations pervaded by a strong industrial spirit. To illustrate the new attitude, I will quote from a lecture recently given at Cambridge by the managing director of a great manufacturing business:—

"Cambridge has trained for the nation a large share of her statesmen, her thinkers, her historians, her teachers, her military and civic leaders; and it is from no lack of appreciation, either of these things or of the contemplative life which is fostered here, that I refer to another avenue of effective life. I feel so sure that industrial affairs also have a large influence upon the progress of the race and the nation that I call for the aid of educated men.

"The door does not lead to a field of assured success, but as a rule it has rich rewards both for men with and without capital, varying according to the power and fitness of the individual. It does not present a satisfactory opening for those who have no capacity to work with other men, nor for those who do not enjoy dealing with life in all its forms. It carries with it an infinite variety of occupation, a chance to pursue and develop scientific thoughts.

"I have not, as a rule, found that the men who interest me are absorbed in the idea of making money for themselves. The remuneration is simply a useful detail. Their minds run in rather an undefined way toward playing the game successfully.

"I can only indicate briefly some of the

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opportunities for a wholesome life in the field under review:—

"An intimate touch with the life of plain people.

"Contact with the grind and sweat of labour.

"A study of the skilful and of the dull worker.

"A frank understanding of the problems faced by a workman's family on an inadequate income.

"Dealing generally with the hopefulness of youth, tempered by the squalor of the improvident.

"Lending a hand in creating work for labour that otherwise will slip away and become unfit for any employment."

I come now to the question of a scientific education as a preparation for affairs. "Science" has been so frequently advocated as an educational panacea that it is as well to examine how far the facts justify this. Perhaps it will lead to clear expression if I state my own conclusions. Number 2 has been arrived at in contradiction to my own previous prejudice. They are:—

(1) That the essential of education for practical affairs is that it should not be an education of "snippets," but should proceed along one main line. A young man should have a "file to bite."

(2) That so far as general affairs are concerned —those which require no special technical knowledge—the scientific education, carried far enough, is as good as any other, but does not appear to be better. But that a minimum of science should be included in every education. This minimum should be something more than that indicated by a late headmaster of a great public school, who wanted his boys taught "as much science as a gentleman ought to know."

(3) That there is, nevertheless, a vast area of possible employment in industry for which a scientific education is *essential*, and that therefore the boy who receives, and is fitted for, a scientific education has exceptional opportunities.

We are making no attempt to decide on broad lines the educational courses in our secondary schools; we merely introduce more subjects in response to popular clamour. Yet we are spending millions on equipment on no considered plan. Provided the machines and buildings are large enough, or expensive enough, and run enough energy to waste each day, we are satisfied. Yet this question of curricula, as every teacher knows, cries for solution; and the schoolmaster, the very man who knows the properties of his raw material, will certainly not have much say in the solution of it. While large sums are lavished on buildings and plant, we keep the pay of our teachers at a level which is absolutely scandalous. I think that if all governing bodies, all State officials concerned, and all benefactors to education, had so much knowledge of science as would enable them, say, to understand what they read in the daily press, or the general drift of a lawsuit in which a scientific question is involved, we should be able to write on the walls of our schools and universities, "Men, not bricks and mortar" I turn to another aspect of the same question. It has been well said that "the ignorant always believe in the false prophet." A man of business ought to be able to form some judgment, from his own knowledge, of the qualifications of any "expert" appointed by him. I have in mind a recent instance in which a mistake made in such a matter is likely to prove disastrous. The right advice was, in this case, particularly easy to get, as there are two or three men whose names and work are well known, any one of whom could have helped the firm in question to make a suitable choice.

I will now deal with my second conclusion. A combination-room story, at my expense, states that I received a telegram in the following words: "Please send traffic officer at once; classic or moral science man preferred." The story, though not accurate, was well founded. I had received a long letter very much to that effect. It is interesting to study the kind of degree taken by about fifty Cambridge men employed in commerce by five or six great organisations. The men are nearly all well under thirty years of age.

I have included in the list every graduate known to me as employed in the houses concerned, in order to avoid any suggestion of selection. 19 graduated in classics, 5 in history, 5 in law, 1 in theology, 4 in modern languages, 8 in mathematics, 5 in engineering, and 8 in natural sciences. They were 52 in all, four of them graduating in more than one subject. The classical ability shows up extremely well, but it must be remembered, in counting heads, that graduates in science have, as a rule, more specialised careers in view.*

Now, this is a peculiarly efficient group of men for their purpose. Two of them only, after a trial, thought themselves unfit for commercial work; a number, with good fortune, it is true, are already occupying positions of high responsibility. Here, then, is an interesting means of considering whether academic ability has any relation to ability for affairs. Speaking generally, the men were chosen with the highest degrees that could be got, consistent with

* It should be observed that the supply of material in law and modern languages is also limited. The degree in theology is, of course, an accident.

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a good manner, a good physique, a certain abundant energy and versatility, as shown by their other interests besides their "work." They were also known to have got on well with their fellows. All these latter qualities were important, but it is believed by experience of these and other cases, covering a fairly wide field, that the factor of academic ability is also important; and, in fact, forty-four of the men fall academically into the First Class or the upper part of the Second. The exceptions are mainly mathematical or engineering students, but the extremely keen competition in these subjects at Cambridge may account for this. It will be seen that this result is in accord with the analysis made at the Galton Laboratory of the class lists in *Literae humaniores* at Oxford, which proves (I quote from memory) that the successful in after-life were mainly distributed over the First and Second Classes, with a slight, but not an overwhelming, preponderance in favour of the first; the proportion of successful men in the lower classes was much less. The careers were, however, as was to be expected from the dates of the class lists, mainly professional.

But an education in science leads to wide opportunities. There is not only the general world of affairs, now to some extent open at university age to a boy of ability, whatever his training may be, literary or scientific, but there is the whole field of technical industry, engineering, and agriculture; there are the scientific departments in India, in some self-governing colonies, in the Crown colonies, and other possibilities too long to enumerate. Yet I cannot satisfy myself that the outcome of the scientific education is at present all it should be; indeed, I think I detect many a case of undeveloped ability, a want of power of expression, above all, which points to a serious defect. The public schools do not turn out enough students of science. The others turn out many, but they seem to be specialised much too early; they are good examinees. I believe that those of real originality suffer less under the system than the rest. But it is given to few of us to be original. If these boys had a reasonable literary bias, and in consequence could think clearly and express themselves clearly in terms of their mother tongue at least, they might be very effective material for the world's purposes. But they are apt to be diffident and tongue-tied, or if not unsure, then too sure of themselves. Both types are common, and they are associated in my mind with the question and answer: "Do you write a fair English essay?" "Ah, I am afraid that is my weak point." I do not think that a training in English would be sufficient in itself; there ought to be an adequate study of at least one difficult foreign language.

Here is a rather brilliant little group of twelve young Cambridge men employed in technical industry. All are, as far as I can tell, likely to rise to considerable distinction. I have chosen them as being employed on the administrative rather than the technical side. It will be observed that eight are First Class men, two graduated in the Second Class, and two in the Third. Their scientific qualifications are about equally divided between pure science and engineering. In several cases there is strongly marked literary power. Of the others, all with one exception have had a good literary basis to their education; for they come either from public schools in which a high literary standard is set, or from a few other large schools of which the same is true. I call to mind two or three other cases in which the ability as recorded by academic performance is equal to the best shown above, and in which there was no fault to find with character; but in some indefinite way the men did not seem broad enough for a career of organisation, and, looking at the early records, I have suspected that the chemical laboratory replaced the Latin grammar at too early a stage.

I now come to the question of the training of young men who aim definitely at a career on the technical, as opposed to the administrative, side of industry. In a general way, the sound opinion seems fortunately to be gaining ground with rapidity. It is that, whatever else is omitted, the training in pure science should be as complete as possible, and that it certainly is not complete without a reasonable amount of research. The latter is especially valuable in developing manipulative skill and self-reliance, and I am inclined to attach the greatest importance to the research period. This, of course, involves a university course of four and, if possible, five years. It is therefore most desirable that the "assisted" student should not have his university career cut too short. If, in consequence, the less able students find their way to the more strictly technical schools, they will actually profit in the long run. Here they will prove capable students, and will become valuable parts of the industrial machine, satisfactory to themselves and to others. The grading of ability is thus of supreme importance. The advantage of examination records for public purposes, or for those who are disposing of public funds, is

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that they are absolutely impartial. That is the reason why, in spite of the acknowledged imperfection of the system, it is difficult to displace. But in the determining of how far a given student should be encouraged and assisted to proceed, it is, I think, most desirable that the opinions of the professors, and others who know best the quality of his mind, should be taken into account.

After a five years' course in a university, the student may have reached the age of twenty-three or twenty-four without having as yet earned a penny. That state of things has not unnaturally evoked criticism, and there have been attempts in high quarters to reduce the age at which a boy enters the university. May I state how I think the matter stands? In the first place you have the almost unanimous opinion of university authorities, that in point of age and mental capacity the earliest profitable age for entry is about eighteen. It may be that boys are at an earlier stage not sufficiently hardened to go through what is, in the case of the industrious student, a very strenuous college course. The relative tenderness of boys at the earlier age, or at least their want of the necessary development fully to profit by their work, is certainly borne in on me at the Appointments Board. I find that, judging by collateral evidence of capacity, a man entering at the earlier age usually graduates in a class at least one, sometimes two, lower than he should; and this is a severe handicap to him in starting his career.

In considering, too, the age at which a man may be supposed to begin work of the highest technical kind, we may compare our own practice with that of our two greatest industrial rivals—Germany and the United States. In these nations the training is considerably longer, and is seldom finished before twenty-seven or twenty-eight, very much as is the case with us in medicine. Here, at least, is an American statement:—"I told my son, when he started in his profession at the age of twenty-nine, after a long training, that he represented an investment of £6,000." It is certainly possible to go on too long, and I know of students who by doing so have missed their market. But I suggest that at the age of twenty-three or twenty-four we have arrived at what is, in our own experience, the ideal age for undertaking the strenuous and taxing work of industrial chemistry.

The catalogue of "what every industrial chemist ought to know" is truly formidable. Here is a list, taken from a discussion published in the *Journal of The Society of Chemical Industry**:—French and German; mathematics, at least up to the elements of the differential and integral calculus; a complete course of laboratory work in inorganic, analytical, physical and organic chemistry; physics; a knowledge of fuel and fuel economy, steam-raising plant, steam-engines, gas-producers, gas and oil engines, electrical generators and motors; water purification, and metallurgy; furnace construction, the general principles of machinery and engineering drawing; business methods and costs of all kinds; economics; a knowledge in particular of the chemical markets, and a knowledge of all the important printed research on his subject. As to the last, of course, the really important thing is to teach the student where and how to look for his knowledge, and, above all, how to judge of its importance. It is obvious that all this knowledge cannot be acquired in four or five years, and we must be grateful that it is being widely recognised that the man who will make the best industrial chemist will be he who makes the most of what a university has to give him, rather than he who spends time at this stage on matters which should really be learnt in the works. I feel sure that academic makeshifts for works experience will ultimately be recognised as unsatisfactory.

This view must of necessity be true of the knowledge of costs. Mr. Blair, in an able paper, containing much valuable matter, read before the British Association at Sheffield, quotes a "college" authority as saying:—"I consider the question of cost in design, and the commercial side generally, receives quite adequate attention in most colleges." The training is, of course, of the utmost importance, but surely the "college" is not the place for it. Swift, in his bitter attack on men of science, shows one of the professors in the Academy of Laputa endeavouring to extract sunbeams from cucumbers. It is an unfortunate instance of satire which has missed its point. The good man was only born two hundred years too soon; he was clearly interested in "reversible processes." But would there be any faculty more worthy of inclusion in Swift's academy than a faculty of "chemical costing"? Imagine a "costs room" in a chemical or engineering laboratory where all the bases are theoretical, where there are no real economic data, where there is no real industrial pressure, where, in short, everything is in the air!

So much, then, for the university, or the technical high school of approximately university

* Vol. XXVIII. No. 6.

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rank. How about the technical schools as a preparation for industrial work? They aim, of course, at educating a different order of student. Are their methods in all respects satisfactory? I have had the curiosity to measure the plans of one of them, a school most lavishly equipped. The space allotted to pure science and engineering was about 40 per cent. of the whole. This space, however, included *all* the lecture-room accommodation, and the professors' and students' rooms. The remaining 60 per cent. of space was allotted to the purely technical processes, such as dyeing, weaving, brewing, etc.

The space allotted to pure chemistry was 3½ per cent. of the whole; that allotted to physics was less. Now, in view of the importance of an elementary knowledge of chemistry in all the work undertaken, of the importance of an advanced knowledge in much, and of a superlative knowledge in the case of some students, the space allotted to pure chemistry is ludicrously small. Either the professors and lecturers must be worked off their heads by duplication of courses or the knowledge of chemistry acquired by the students (there is, fortunately, no question of the skill or eminence of the staff) must be extremely rudimentary; probably both statements are true. In any case, the proportion points to a want of appreciation of the value of pure science on the part of those originally responsible. The ideal of a technical industrial process is that it should be automatic, and all good processes tend to become so; a working knowledge of them is, therefore, much easier to acquire than a knowledge of the science, which is hard. A student tends to follow the line of least resistance; and as he deals in the works in any case with an automatic process, his final equipment is apt to be unsatisfactory and disappointing. I am told that some technical schools have really done a great deal of harm in this way.

For want of space and of exact figures, I must leave aside the question of how it will be possible to renew these large plants; when they are out of date they will become positively harmful. And is it seriously proposed to spend on the equipment of these schools a quarter or half a million every fifteen years or so? I cannot but think that the money could be better used, even if it could be found.

One last word on this matter. There has been much discussion of the question of working in bulk. Well, in every large and well-appointed laboratory work is frequently done on the cwt. scale; is the ton scale any better, really, for students? Or is there not quite as much transition from the gramme scale to the cwt. scale as from the ton to the twenty or fifty ton? I read of the miserable spectacle of "squads of students" watching the process in "miniature bulk" go through. They cannot all handle the process, and to be mere bystanders is apt to be a waste of time. In any case, the transference of a particular process from the laboratory to the works stage must be a delicate matter, individual for each process, and essentially a matter for experience in the works.

I come now to the question of supply and demand. I am told by good authorities that a great deal of the criticism levelled at the English industrial world on the subject of its neglect of chemistry is very much beside the mark. Take the often quoted case of the aniline industry. The real reason of its leaving the country is hardly fairly presented. The Prince Consort's foresight led him to bring A. W. von Hofmann to London, and the latter was given the opportunity of organising the College of Chemistry in Oxford Street, which developed into the Royal College of Science. The Prince Consort's death was the real disaster. Hofmann and the German colleagues whom he had introduced lost their natural protector and patron. Hofmann was soon attracted back to Berlin. His companions followed him, and naturally took much of the skilled knowledge of the newly-founded industry with them. In a few years Germany had the chief outlines of the coal-tar colour industry mapped out in its patent literature. With the start thus acquired, it was almost impossible that a competition of a serious character could come from this country. The case of the coal-tar dyes is frequently quoted against us. But while our imports of these from Germany are worth £1,683,000, we have, on the other side, immense exports of rough inorganic chemicals to that country. A Cambridge man in business in the Midlands tells the same tale. "I can assure you that, whatever may be the case in other parts of the country, the manufacturers in my neighbourhood are fully alive to the importance of science."

I may be asked, then, are we at Cambridge satisfied with the attitude of manufacturers? The answer is, broadly, Yes. We could fill more good places than we have men for, and I am very much relieved, where I should have been anxious a few years ago, to know that the number of students reading advanced chemistry at Cambridge has precisely doubled

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in this last year. It is gratifying, too, to find great concerns giving us a general order to report whenever we have ready a man who is likely to satisfy their requirements.

A general idea of what happens to those who specialise in chemistry may be enlightening. Dealing with a small compact body of men of this kind, of course it is extremely important to avoid any kind of identification. I have not, therefore, taken a particular year; but have proceeded on an automatic principle which has left nothing to judgment in the way of selection in order that classes of the more and the less successful might be represented. The method adopted necessarily involves the inclusion of one or two men whose destinations are not finally settled; but there is no reasonable doubt that they are allocated to the right classes. Their destination appears to be as follows: 13 per cent. are or will be ultimately teachers or researchers of the highest rank; 15 per cent. will be occupied in public schools and important technical schools; 58 per cent. will be employed in industry, either as chemists or managers—a few of these will be in their fathers' businesses; about 5 per cent may be absorbed by agricultural research; as to the remaining 10 per cent. I can give no information.

In speaking of these men it must be remembered that, though they ultimately specialise in chemistry, our Cambridge system insists on a wider training in the early part of their career in several branches of natural science, such as physics, geology, and botany, and, as a rule, three subjects are taken in the earlier years. In some respects it is possible that the present system might be improved; there is a tendency to devote more time to research and less to the formal examination, and probably it should be more easy than it is to spend a little time in the engineering laboratories, just as the engineers often do some chemistry.

In order not to rely entirely on our own impressions, I have examined the output of one of the higher technical colleges where a diploma of associate in chemistry is given, and where the work reaches a high standard. During eighteen years they turned out on an average four or five chemists a year of the requisite standard. There were ninety candidates who obtained the diploma in all. During the first period there were between three and four a year, and during the second part of the period between six and seven. Men of this order of ability in chemistry are produced in relatively small quantities, and I do not think that the output is at all unsatisfactory. The associates are younger than our graduates, and are not so widely trained. But they acquire a good knowledge of chemistry, and the school has produced some eminent men.

The data work out as follows: The number of associates employed in technical industry is 64 per cent. I do not know the nature of the career in the case of all the employing firms; but I happen to know that some of the careers are very good. The higher branches of teaching absorb 10 per cent. These are professors in this country or at colonial universities; 10 per cent. are consulting chemists or analysts. The Government service has taken 6 per cent. Another 6 per cent. are in schools—in the last two categories there are several women—and, finally, 3 per cent. are unclassified. Of the latter some did not definitely follow a chemical career. I think this must be regarded as a most satisfactory result, and one on which the school in question may be highly congratulated. When it is considered that not every man who reaches the necessary scientific standard is fitted to engage in business, the wastage here is really very small, and the careers of the 14 or 15 per cent. who are not engaged in technical chemistry in some form or other appear to be satisfactory ones; in fact, I believe, that dissatisfaction, so far as it exists, comes mostly from the unfit.

Now, though the conditions of employment in the case of the more highly trained men, as shown above, are satisfactory, there are two points to which I should like to allude:—

(1) Commencing stipends are often all that can be desired, and some firms show a generous appreciation of the fact that, though a man cannot be immediately useful, still a large sum has been spent on his education, and he cannot be expected to look with any satisfaction on the offer of work at a salary which is temporarily small. I think the conditions in the first year or two should be laid down rather more definitely than is sometimes the case, and that a little more liberality in this respect would do something to increase the number of men who adopt technical chemistry as a career. I do not think that the initial salary should be so much as to debar satisfaction at subsequent and fairly immediate increases, but I believe that an initial contract which gave a relatively small pay for six months, say, at the rate of between £100 or £150 a year, and after that a guarantee, in the case of satisfaction, of a commencing stipend of £200, would be found to be satisfactory.

(2) There is another point. I am not so wel

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satisfied with the prospects of employment for a rather different class of man as a process conductor, a man who might rise to be a useful business man, either in the works or in other parts of the administration. Such a man, while giving evidence of good ability, say, in Part I of the Natural Sciences Tripos, would be chosen very largely on personal characteristics. He would be very much like the class of man engaged in business administration to which I have alluded in the first part of my paper. He would, above all, be a cheerful person in himself and capable of getting work in a cheerful way out of others. I have in mind a little homogeneous group of four or five men in the employment of one firm, who exactly fit the situation; and I feel, therefore, that there ought to be a wide ground in industry for the profitable employment of such men.

It is just possible that if English contracts with technical men were a little less stringent, the tendency of good men to seek a career in commercial chemistry might be somewhat increased. I give no dogmatic opinion. I know the great difficulty of the problem, and there is certainly a tendency to make contracts much more stringent than formerly. Cases of breach of contract appear to be very seldom brought into court, and I am told that it is exceedingly difficult to say what contract is good in law, and what is not; the courts will decide each separate case on the ground of what appears to be reasonable. I am sure British manufacturers have considered their ground most carefully, and it would be a mistake to desire any change which would harm British industry or make it more difficult than it is at present for a scientifically trained man to find a reasonable place in it. I had, however, the curiosity to inquire what was the practice in Germany with regard to contracts, and through the kindness of a friend I have been informed of the general nature of German contracts.

My friend has had in the past a most successful experience as a manufacturer, and it is to be noticed that he takes a sympathetic view of the considerable protection which the German law affords the employee. "Contracts," he said, "which bind a scientific assistant for so long a period as you suggest have fortunately long been given up in Germany. Our legislature, and still more our courts, take a strong line in favour of the economically weaker person." In the case of commercial employees, no contract which places an unreasonable hindrance in the way of the success of the employee is binding, and on no account whatever can any restrictive conditions apply after three years from the termination of the contract. Scientific assistants do not, however, come under the commercial law. The professional law protects them against exploitation by industry, but not so clearly as the commercial law does those to whom it applies. Hence a constant agitation by them for a protection similar to that given to the purely commercial man.

A common form of contract for the scientific assistant would not appear to be very different from the English, except that its restrictive clauses would be less severe. For instance, the chemist might be bound for a very short period not to enter into or create a similar business, but if, within that period, an offer of that kind is made to him, then he would have the right to compensation in view of his refusal. He might also be bound to secrecy for three or four years. A quite recent decision of the Supreme Court carries the matter still further, at least in the case, apparently, of the commercial employee. According to this decision all secrets which he may have acquired in the course of his business, scientific or otherwise, are part of his fair economic equipment, and he may turn them to account directly his contract ceases, provided he has acquired them in the normal and proper exercise of his employment, and not by sharp practice. Should there be an improper use made of them, it is against the new *employer* that the remedy lies. If secrets are betrayed by an employee before his engagement terminates, both he who betrays the secret and he who uses it are liable to a penalty. The liberal tendency of the German law can hardly be out of sympathy with general opinion. But its importance could not be properly estimated without ascertaining the opinion of German manufacturers, and that would be difficult to do. Whichever tendency is right, the German or the British, it is clear that the employer should do his best to ascertain the entire trustworthiness of the man whom he engages.

It must not be supposed that the industrial chemist is the only type of graduate for whom there is a demand. Agriculture has just awakened to the fact that the scientifically trained man can be of the greatest use. Until twenty years or so ago, the only science which had really established any definite claim to assist agriculture was chemistry. Even then every country, every colony, every agricultural society had its trained chemist. But in those days the chemist largely confined his attention to analysing manures, foods, and other agricultural commodities.

All this is now changed. There are still

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analysts who perform the invaluable function of controlling the sale of fertilisers and feeding stuffs, but agriculture is nowadays employing scientific chemists to investigate such subjects as the problems of soil fertility and the growth of crops, and the laws of nutrition of animals. Botany, too, has established itself as a valuable ally—not only in the routine work of seed-testing and such-like, but in the investigations of plant-breeding and disease resistance. The trained entomologist, the bacteriologist, and the geologist, are frequently called for.

In fact, at the present time, the demand for young men with a sound scientific training followed by a good training in one of the branches of agricultural science is greater than the supply. This demand will increase as the agricultural departments in India, Egypt, South Africa, and the West Indies, become more efficiently organised. The demand at home, too, must increase as new posts are created throughout the country under the stimulus of the Development Fund This is much to be desired, for agricultural education in England has been hindered by the fact that the salaries and prospects have been too poor to attract the best men.

The question of the employment and of the education of engineers is a good deal simpler. As regards education, a theoretical course is now generally admitted to be desirable. In this, a considerable handling of tools and machines is of course essential, and this accounts for the very large space occupied by the engineering department of the technical school I mentioned above. A student even in the drawing office wants a good deal of room. In the case of engineering laboratories, however, there seems to be a tendency to unnecessary size of machinery, with all the attendant expenses of energy running to waste, more lighting, heating, higher rent and rates. Besides, apart from the mistake of running a 200 horse-power engine when a 20 horse-power will do, you can, I presume, for the same current cost, run ten 20 horse-power engines at once. Now this is a great advantage, for, as a fact, it is a complaint of students who have learned in the laboratories equipped on the larger scale that they far too often have merely to look on idly when they wish to handle things for themselves.

Owing to the enlightened policy of many of the great firms of mechanical engineers, a student's practical training is nowadays easy to get. Premiums are the exception, and I know firms who will help out a student of more than average ability.

The general situation may be gathered from a paper issued by our Appointments Board in 1910. Sir William Mather suggested that we should make a census of our past engineering students, and he kindly drew up a report for the consideration of the Board, on which report this paper is based. Returns were obtained for 176 graduates, 133 of whom belonged to the years 1902–6. The average age of these was about twenty-eight. I quote from the paper :—

"The employment of the 176 graduates at the beginning of 1909 may be roughly classified as follows :—

1.	Directors or Partners in manufacturing concerns	10
2.	Partners in Consulting Engineering firms	14
3.	Subordinate positions in manufacturing firms (ranging from Draughtsman or Works-Manager's Assistant up to Works Manager)	49
4.	Assistants to Consulting Engineers	9
5.	Professors or Heads of Teaching Institutions	6
6.	Assistant Teachers	17
7.	In service of Government, Municipalities, or Railway Companies in the British Isles	12
8.	Government Engineering Services abroad	28
9.	Miscellaneous	31

"As was to be expected, no return of remuneration was furnished in most of the cases coming under headings 1 and 2, but where the graduate is a director or partner in a well-known firm, it may be surmised that the remuneration is satisfactory and probably much in excess of that earned by men in subordinate positions. In some cases the graduates in classes 1 and 2 had entered established businesses; in others, they had started concerns of their own—in several instances with marked success. The salaries of the men coming under heading 3 varied from £150 for the youngest up to about £500, the average being about £200. The salaries of those who were in the teaching profession varied from £170 to £1,000, the average being about £400. The salary of a man of twenty-nine employed in the Government Engineering Service in India would be about £460.

"These figures as to remuneration support the conclusion that until he is about thirty years of age a Cambridge graduate in engineering can earn considerably more as a teacher or in Government employment than if he enters the service of a private firm; on the other hand, the salaries of the higher officials in private firms are probably superior to those attached to positions of equal responsibility in Government or municipal services, and, of course, the remuneration of those in the highest places is very much greater. In the teaching profession also the pay is better at first,

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but not so good in the long run, as in practical engineering work. The salaries of the twenty-three teachers referred to in this return, however, are probably above the average, because one-fourth of them are occupying well-paid posts as professors or heads of institutions, and many spent two or three years before or after graduation in acquiring practical experience, which is now an essential qualification for the better-paid posts of this character.

"Among those coming under the heading 'Miscellaneous' (No. 9 above) are seven barristers, four of whom are in active practice and the others in course of preparation, three journalists, two soldiers, two architects, one artist, a clergyman, and a missionary. Three are engaged in scientific research, two at the National Physical Laboratory, and the remainder in commercial pursuits of various kinds. It has been from the outset a guiding principle with those responsible for the conduct of the engineering school that the course of instruction there should not be inferior to the older studies of the University as a general training of the mind, useful to anyone whether he become an engineer or not. The considerable number of men who, after graduating in Engineering, have been successful in other walks of life, is some evidence that the policy of the school in this respect has attained its objects.

"A few remarks may be added as to the course followed by Cambridge graduates in the two years immediately after graduation. In the year 1908—which may be taken as typical—forty-three men graduated in the Mechanical Sciences Tripos, but of these only thirty obtained honours, the remaining thirteen being allowed the ordinary degree. The situations filled by these men at the beginning of 1909 are known in every case but two, and were as follows:—

1.	Premium Apprentices in Works	5
2.	Premium Pupils with Civil Engineers	5
3.	Pupils or Apprentices not paying a premium	13
4.	Salaried Posts (one teacher)	6
5.	Still at Cambridge	7
6.	Employment other than Engineering	2
7.	No employment (one ill)	3

"Of the seven men who appear under heading 5, as spending a fourth year at Cambridge, five were engaged in research at the Engineering Laboratory.

"It may be added that most Cambridge men come straight to the University from school, and get the whole of their practical experience after graduation. A small proportion, however, perhaps two or three per annum, have spent more or less time in works before entering the University. There is no evidence in the information summarised in this circular that this procedure is either better or worse than the other.

"In addition to those who enter for the Mechanical Sciences Tripos, from thirty to forty students per annum proceed to the ordinary degree by taking the Special Examination in Mechanism. This examination is easier than the Tripos, and adapted for men who have not much aptitude for mathematics. A common practice for such men is to enter for the Associate Membership Examination of the Institution of Civil Engineers, which they generally have very little difficulty in passing, a few months after graduation. They then go into works as apprentices, and follow much the same course as Honours men. While not equal to Honours men on the average in technical knowledge and ability, many of them have excellent business capacity and do well in practical life."

The situation with regard to civil engineers in this country is not by any means so satisfactory as is the case with those who go to the mechanical firms. In the first place the premium requisite for entry into a first-class firm is a very large one, and is prohibitive to many students. The remedy is not easy to see, for the pupil of a great civil engineer gets a very valuable training in return for his premium. But the fact remains that many of the abler men are excluded. In the second case, work in an old country is naturally scarce, and, thirdly, so much civil work is dependent on borrowed capital that a general rise in the rate of interest tends to prevent the execution of all but the barely necessary. Further, I seriously doubt whether the services of corporations, municipalities, etc., are recruited in a really satisfactory way. The Government services on the other hand, and those public enterprises abroad, the officering of which is entrusted to eminent civil engineers in this country, are well recruited. A few great railways take a very enlightened course, and do not allow premium pupils. In others, the premiums paid to the chief engineer are high, and it is moreover suggested in some cases that the better posts in the service are a close preserve; though why this should be, considering that the capital is that of the shareholders at large, it is difficult to say.

I have laid stress on training in pure science. Fortunately, nowadays, we are far from the attitude which held that directly a discovery became economically profitable the treatment of it should at once be excluded from any educational course. Yet that, or something like it, is an attitude which is, or has been held. But there are not two kinds of science, there is only one. Employed for purposes of production, a given line of research may not be worth carrying out, however fascinating it may be from the scientific point of view. And even in the cases in which a discovery is economically profitable a manufacturer may have to pigeonhole the patent for a long period; he may have already a more

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costly process at work, involving an elaborate plant, and, unless he sees that he can put the product on the market with a sufficiently greater margin of profit to himself, he may not be justified in the new capital outlay. It is so easy to talk of "scrapping" plant. His attitude is not even necessarily anti-social; it may not be the best for the consumer at the moment; but if he is a good employer he may think of the large area over which he will have to disturb the conditions of employment of his own workmen. It is all the more important then that pure science as opposed to the creating of processes should be heavily endowed. The chemist or the biologist must be able to pursue investigations which are not immediately profitable. I may illustrate by the case of bio-chemistry. It is a science which lies at the root of the problem of plant and animal disease, plant and animal nutrition, and so is fundamental to medicine, to agriculture, to stock breeders and to the feeding of the classes who have not sufficient means to secure a "mixed diet." And in all these directions there are problems of the first magnitude awaiting solution. Yet the amount of research done in England has been very much less than it should have been, simply because the difficulty of the immediate steps in research has been realised, and there has not been a sufficient livelihood or equipment for those who were known to be fitted to overcome those difficulties. It is not by direct means only that science can serve industry.

DISCUSSION.

The Chairman (Sir Henry Miers) said the author had directed with conspicuous success during the last ten years the most successful of all the Appointment Boards in the British Isles, and in his paper had opened up many matters of importance to educational experts. There was no more important duty falling on the universities than that of fitting their students for the places they had to occupy in life, and there was no greater responsibility on employers of labour than to obtain the best material from all sources, universities and other educational institutions. One point to be borne in mind was that a residential university like Cambridge, in recommending students, had the very great advantage of being able to refer not only to the results of examinations, but to prolonged personal knowledge of the student, and he thought Mr. Roberts would be the first to confess that such recommendations were influenced as much from such personal knowledge as from the examination successes.

Mr. R. Blair (Education Officer, London County Council) said there was probably no man in England who had had so much experience in "marketing goods" of the peculiar kind which universities produced as the author. Educational institutions would do well to give far more attention to that matter than they had hitherto done, and to remember that a boy had to make his way in the world, and that some sort of provision should be made for that purpose. The Cambridge Appointments Board had done a great deal to show other authorities how the industrial and commercial world could be linked up to the university. It occurred to him that a subsidiary name for the paper might be "The Supply, the Training and the Placing of the First Class Man." Taking first the supply, he thought the country had a very much larger untapped supply amongst the population of the small towns and villages than was generally thought to be the case, a supply which the northern part of Great Britain had drawn on for some considerable time. It was perfectly clear that the First Class man must possess many qualifications, amongst which were strength of character and mental and physical strength. Often the poor man had a struggle at his secondary school and his university, a real physical struggle to keep his position in the university alongside of men who had been better housed and fed, and he also had the struggle of the examinations, and when entering, for instance, the Indian Civil Service, he had a further struggle in learning the Indian language, a struggle with the climate, and the final struggle some day of taking full responsibility. If he had not harboured his strength for that day it would not go well with him. That showed how difficult it was for the poor man to maintain his path with his physical strength unimpaired, and it also suggested that the present method of scholarships needed considerable modification. He should like to believe that the remark quoted by the author of the business house that "We must have the best ability that we can command, and it is to our interest to pay well to attain it," was absolutely true, especially in connection with commerce. He thought the tables the author had shown referred more to technical experts and not so much to the commercial side of the business. A great deal had yet to be done to get the best educated men into commerce, to find a door as it were into the City different from the present one, which was largely a matter of influence. There was an indication in the paper that the author thought far more of a wide and deep education of a general character than he did of what might be called an education of the process type, such as was seen in the planning of a particular technical school where much was devoted to processes as compared to what was devoted to true education. Some little time ago he was concerned in a report that dealt with an institution of a highly scientific character, and on showing the report to one of the ablest minds in England he was told: "It is no use bothering your head about that. Englishmen can never be great scientists. The English characteristics are of a practical kind." He did not think that was true. England had

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been slow to adopt what might be called sound educational systems for the mass of her population, and there had been a tendency on the part of those who had not been well educated to call out for practical men. His own experience of managing men was that a man could be kept far too long at one particular job; there was nothing so soul-destroying as what might be called over-development in a particular direction. He got to know that particular work, but his ability was killed for any other purpose. He should like to know why the author thought that the schoolmaster would not have much say in the solution of the problem. The diagrams the author had given seemed to indicate one thing, that the First Class man was a first-class man. It would have been interesting to follow up the cases of the nineteen classical men, because possibly it would be found that in their schools they were kept on the classical side owing to the fact that they were the ablest students in the school. It had been true of most public schools, and he believed it was true also of most secondary schools, that the ablest pupils had been kept in what was regarded as the best side of the school. He did not think it mattered as a rule whether the First Class man was put on to one subject or another. Many of the men would have done their mathematics as well as they had done their classics, while others would do classics as well as they had done mathematics. His impression was that men learnt by compartments, that the mind ran far more in compartments than had hitherto been appreciated. In other words, a man might learn one subject very well, but his experience in learning it might be really of very little use to him when he turned to another subject, unless he was really a keen man. What was really wanted, therefore, was first-class ability and keenness in turning almost in any direction. But that keenness was kept up by a wide range of ideas, and that was where the real benefit of a classical education came in. It was far less narrow even than what was called a good, broad, scientific education. He might illustrate the point of compartments a little further. The most distinguished scientists were men who were engaged day by day in weighing evidence as to one chemical product, and judging development in one direction or another; but if one of those scientists were put on the judge's bench for six months he might show that the capacity for weighing evidence in one direction might be of great benefit from the point of view of weighing evidence in another. He believed that after six or twelve months' experience in the second position, the first-class scientist might become a first-class judge. He was interested in seeing the list of subjects which an industrial chemist was supposed to be acquainted with, but he thought the author would prefer a good general education to specialisation of that kind. Nowadays, if the head of a great shipbuilding firm wanted to know how to apply oil-engines to the propulsion of ships, he did not study it as one would do in a laboratory, but he went to the people who made oil-engines, and to those who were experimenting on the subject, and very soon appreciated the advantages of oil-engines from the point of view of propulsion of ships. There was one important aspect of industrial chemistry which had not been mentioned. He had been told within the last twenty-four hours by a chemist who had applied himself to photography, a young man who was getting a large salary, that there was room at the present moment for from ten to twenty chemists versed in the application of chemistry to photography. With regard to bio-chemistry, the very widest fields were being opened up to able young men. The British Empire contained within it more acres devoted to rubber, tea, coffee and cocoa than any other large political division of the world, and he was told there were firms in London who would be glad to get young men of twenty to thirty who had the personal and technical qualifications to enable them to take a leading position in those fields. He also learnt, somewhat to his dismay, that the young men who had recently been sent out had been found in Germany. He was glad to think it was true that teaching in London was being developed on lines that would provide a good supply of young men for the purpose. He was glad also to see the note of hopefulness in the paper that things had greatly improved within the last ten years, and he thought that was due a good deal to what the universities had done, and to the work of men engaged in industrial enterprises. The British manufacturer or merchant after all was not such a bad fellow as he was painted.

Professor Roberts Beaumont said systematised science directed to the development or improvement of some industrial work or series of processes lay at the very foundation of commercial and industrial prosperity; but unless science was directed he thought it would fail to affect, as it ought to affect, the industry of this country, and would not reach those students who wished to prepare themselves for an industrial career. General education in science, whilst laying a broad foundation and giving a broad outlook on life, was not exactly the education which equipped a man for the modern industrial struggle. He did not care himself about the so-called German or American competition, provided that the scientific and technological classes of this country were filled with young men of intellectual capacity with a disposition to acquire the science and technique connected with industrial work. Mr. Blair had spoken of the processes of educational methods as though they were in some way distinct from scientific methods. It was a fact that where one had first experiment which was educational—the training of the mind, the demonstration of principles and data—and secondly experiment for investigation and research, there was the very essence of science. In the most technical subjects, mining or textile, there was a scheme of experiment of the first type pursued by the advanced student of the second type,

and a combination of those two produced a science requiring exactly the same type of mental capacity as any other branch of science which might be demonstrated in the lecture room. He had had considerable experience of human capacity for the reception and utilisation of knowledge, and was one of those who suggested to the West Riding County Council that they should establish scholarships to select from the deserving and intellectually capable in the local schools the children of working-men for drafting into the university, where they might acquire a full training in the science and technology of their subjects. With regard to the possibility of such men attaining success, he held that at the end of their courses of study, unless one could find for them a good position —not necessarily good in a financial sense, but a position in which a rapid advance could be made to higher attainments—the purpose for which the educational scheme was established would fail. His experience was that scientific training had been one of the greatest boons ever given to the country. He could remember the days of absolute prejudice against scientific education in connection with industrial work, but it was recognised now to be a necessary preparation for industrial work. The question that arose was whether appointments were being obtained by those who were trained in the universities. His experience enabled him to say that men trained in the universities were occupying good positions in Japan, China, India, South Africa, Australia, New Zealand, Canada, America, and most of the Continental countries, and that in itself was evidence of the efficiency of the tuition and the value of scientific education as a groundwork for industrial pursuit. At home the advantages had been equally great. But such education must touch the worker of every grade of industry. Wherever a man exercised intellectual capacity in his work he had a right to benefit in any educational scheme of science in relation to industry.

MR. VERNON M. MARTIN said that as a younger member of a firm who felt they had attained a certain amount of prosperity by the older methods, he might say that when some of the younger members of the staff went off to the war in South Africa, the firm determined to approach the Appointments Board at Cambridge to see what they could obtain. He was deputed to go to Cambridge, and was quite astonished at the amount of talent which was available. The firm had never regretted the step then taken, and, when another vacancy was created, those who originally opposed the suggestion were the first to ask for another man of the same type.

MR. RICHARD B. PILCHER (Registrar of the Institute of Chemistry) said the Institute drew its best candidates for examinations from some thirty recognised colleges and universities, and all the candidates were required to have had the kind of training given at Cambridge. They had to go through a course of at least three years' systematic day training of a university character before being admitted to the professional examinations. At the present day some 45 per cent. of members had university degrees in addition to their fellowship or associateship, and if associateships of the Royal College of Science and diplomas of that order were included, the percentage would be much higher. The Institute had 1,400 members, and he thought there were very few bodies that could claim such a high representation of university men. Their standard of practical chemistry was very high, and it was not to be wondered at that very few of the members were unemployed; it would be difficult for him to name two who were out of employment. It was also rare for any young associate to accept an appointment under £120 per annum. Salary was an important matter. It was his experience that when men reached from £200 to £250 a year they found it difficult to get any further unless they were in a place that afforded considerable prospects. It was an important matter to consider what the young man was going to do when he had the training. In one big laboratory alone he had placed ten men during the past year on a starting salary of £120, and four men at £150, with guaranteed rises of £10 a year for four years, and a definite contract at the end of that time in a certain well-known works. As a young man who had to pay for his children's education, he felt it rather a hardship that scholarships were restricted to the children of people earning no more than £160 a year. Having regard to the expenses of education, he thought there were a large number of people with moderate salaries who would feel it a great benefit if such scholarships were opened to their children. He considered that a time was now coming when many vacancies, particularly in the teaching profession, were likely to become open, chiefly owing to the fact that the men who were appointed thirty-five or forty years ago, when so many new institutions were established, were now getting old and ready to retire.

MR. HORACE M. WYATT looked upon the paper as setting forth the truth that a liberal education was essential even in the most specialised professions, and he thought the success of university men was due as much to the liberal education received at a university as to the efficiency of the scientific training. The liberal education of a public school and university brought out certain qualities which were of the greatest possible value in business, and business men were beginning to realise this fact, and would realise it more fully in the future. A man who had passed through a public school and the university had certain ideals of discipline both with regard to himself and those under him, possessed tact, and had a code of honour which created respect. During the last few years he had managed to get into the firm with which he was connected five university men, three from Oxford and two from Cambridge, and the success of the experiments had led to his being asked by

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the various departments to obtain others. He regretted that there existed no Appointments Board, dealing with public-school boys who did not go on to the universities. Such a boy had had a training which fitted him for certain posts, but there was no organisation to help him to get them. He had given some consideration to the matter, and in the event of sufficient influential men interesting themselves in the formation of a board or committee, he believed the matter could be dealt with, without the necessity, in the first instance, of any financial assistance, as that would be forthcoming from men who believed in the principle that something definite should be done to bring the public-school boy into direct contact with the commercial community.

MR. WALTER F. REID said he had found employment for some hundreds of young men in various industries, especially those connected with chemical products, and he believed there were many places to be found for highly-trained men, particularly those who had passed the Fellowship examination of the Institute of Chemistry. But nothing had been said as to men of lower grade, such as foremen, who were absolutely necessary in all works. France had long ago realised the necessity not only for training in the higher branches, but for training those whom they had to control, the men who were actually engaged in industrial work. He thought that to some extent the author had made no clear distinction between industry and commerce, and he was of opinion that the men dealt with in the diagrams had chiefly gone into commerce. A large commercial concern required men with ability different from that required to manage large industrial works. In his presidential address to the Society of Chemical Industry, at Sheffield, he had quoted some interesting figures given by Mr. Barker North. Taking the nine chief industries in the country, Mr. North analysed the amount per £100 paid in wages and salaries, and showed that the chemical manufacturer expended £11 7*s*. in salaries and £88 3*s*. in wages. The average output in value of the industries per head of those employed was £93, while the yield per head of those employed in the chemical industry was £185. It would be found that the value to the nation of trained men paid over and over again the cost of the education they received. With regard to the aniline industry, which was the *bête noir* of the average manufacturer, it was not quite true to say that when Hofmann returned to Germany he took the aniline industry with him. As one who followed him to Germany, he could say that Hofmann was not a colour chemist, and did not claim to be so or desire his students to specialise in that industry. English manufacturers at that time controlled the business by their patents, and made so much money out of it that they ceased to care whether the industry developed or not, and when the thing dropped, the Germans took it up, and by skill and patience developed it to an enormous extent. With regard to the quotation from the *Journal of the Society of Chemical Industry*, setting forth the number of things necessary for the training of a chemist, it should be understood that it referred not to the student, but to the chemist in charge of works, who not only had to have some knowledge of the subjects mentioned, but also had to know something of mineralogy. Under modern industrial conditions, a man, to keep himself up to date, had to study day and night to be on equal terms with his competitors.

MR. JOHN W. SHAW said that the author appeared to be somewhat pessimistic with regard to appointments under municipal corporations, but there was no doubt that in the future municipalities would be employing more and more trained men, and it would be of benefit if the author could state what he considered to be the weak spot in municipal service, and point out in what direction it could be strengthened. It seemed to him that the State and municipalities had the advantage that they could offer university men posts quite free from the ordinary commercial spirit, and more in accordance with the spirit of pure science, and, having regard to the fact that they offered a steadier career, could afford to buy ability at a lower figure than the commercial man.

MR. F. W. GOODENOUGH thought the reason why a door had not been opened into the City was that universities had so far failed to realise that there was a science of business. There was a Chair of Business Science at Harvard, and the Americans were far ahead of this country in training men in scientific business administration as distinct from the science needed for manufacture.

MR. ROBERTS, replying to the discussion, said that with regard to the schoolmaster having control, it seemed to him that educational reformers pushed their own fads so hard that the unfortunate schoolmaster was squeezed out. If the Board of Education succeeded in their present endeavour to organise the profession from top to bottom so that the elementary, secondary, and technical teachers might be one in expression of opinion, possibly the schoolmasters would have a chance, but at present they were between the upper and nether millstones, regarded, as could be seen by the salaries, as almost beneath contempt. He did not shut his eyes to the good work done by the Board of Education and the London County Council, and such bodies, but until the teaching profession was organised there would be no satisfactory method of giving weight to their opinions. He agreed with Mr. Blair as to the good stuff produced in the small towns and villages, and wished he could be as satisfied about the large towns. He was told it was the same all over Europe, and that even in Japan the people who congregated in the industrial towns were gradually losing their old characteristics and physique and vigour. He was hardly in absolute agreement with Professor Beaumont; they

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naturally approached the matter from different points. Perhaps the truth, as in other cases, might be found in the wise remark made to him by Sir Benjamin Brown, when discussing the training of engineers—whether the boy should go straight into the works after leaving the university, or should adopt the half-time system, or should go into the works before entering the university—that "the truth is, there is no one way of producing an engineer; there are a dozen or more." He was interested in Mr. Wyatt's suggestion with regard to the public-school boy, and knew of one case of a public school with a small Appointments Board, the secretary of which was inundated with applications. Probably there was a wide field in that direction, and it would be thought that the headmasters of such schools as the City of London and St. Paul's would have numerous applications. With regard to the diagrams, No. 1 dealt with commercial men, and No. 3 with men who had entered industries. With reference to municipal corporations, it seemed to him the matter was carried out in what might be called a hole-and-corner way. There was possibly an advertisement in the public press, but he was not always satisfied that the committees dealing with the applications were really competent to judge of professional standing and experience. He believed that if the applications were referred to a committee of engineers, possibly the Institution of Civil Engineers itself, the ultimate selection being made by the corporation, it would be a better method of laying stress upon the professional value of the applications.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author, and the meeting terminated.

THE DEVELOPMENTS OF THE TEXTILE INDUSTRY.

In general the textile industries are well engaged, and the most troublesome complications in front of them are rather external than internal. The cotton trade has not lost its sense of thankfulness at being back in full work, and its looms have assured work for six months or more at profits which cotton spinners envy, but do not currently obtain. A chance of a fall in raw cotton soon, and an uncertain prospect for the autumn, are foreseen contingencies. India, which is always the largest market, has been much the largest buyer this year, and before the year end may be uncomfortably overloaded. There remains the question of how far China will have recovered its buying power by that time, and of what other markets can do to compensate for the anticipated slackening of Indian demand.

A fall is expected also in the price of wool as soon as the delayed and accumulated supplies of South American cross-bred wool are available for transit. The finer botany or merino classes are comparatively unaffected, and spinners of these are in a better position than their fellows. After a three years' run of almost unexampled prosperity, worsted spinners have fallen upon times of relative adversity. After being the kings of the situation, able on the one hand to restrain the price of tops, or combed wool, and able on the other to pick and choose between customers and classes of business, they are reduced to a much humbler estate. Knowing the difficulty of getting yarn when it was wanted, their manufacturing customers ordered in excess of their actual requirements, and from day to day prices of wool and prices of yarn have both been against the spinner, whose profitable margins have been melting fast. Relatively to the amount of business done, the topmakers (who buy wool raw and sell it combed) have gained ground where spinners have lost. The worsted manufacturers who weave the cheaper yarns which are now forthcoming have suffered less than their suppliers. The carded woollen manufacturers who consume the short wools and rag wool have extremely little to complain about, although some of them join with worsted manufacturers in denouncing as an iniquity the hobble-skirt which has so restricted the yardage necessary to a dress.

The position of the stuff manufacturers whose traditional business is to produce light fabrics, mostly with a cotton warp and a worsted weft, might have been much more embarrassing but for the introduction of artificial silk. Many hundreds of looms in the Bradford area now run continuously in manufacturing fancy cotton cloths ornamented with threads of artificial silk. Doubtless, real silk is supplanted by the newcomer in one degree or another, but silk had already given way in this department before mercerised cotton. The viscose silk supplants mercerised cotton, and even mohair and bright wools, in making goods chiefly for evening or for tropical wear by women. Brightness is their prime characteristic, and coupled with this is a lightness of weight which is of great practical utility in reducing the final cost of goods which are charged with import duty upon a weight basis. The artificial silk is used preferably in slack twists, as it can only be twisted tightly at some sacrifice of lustre. Commonly, it is used as effect-threads more than as an integral part of the main structure, but there are cloths, simulating mohair, in which the entire weft is artificial silk. Great durability is not a claim that can be advanced for this material, and the artificial silk, besides having a more metallic glare, refuses to spread and cover so well in weaving as does natural silk. Nitrated silk and cupro-ammonium silk are not unknown and are admired for their lustre, but viscose silk, of the sort that is now made at the rate of twenty tons weekly in Coventry, is preferred for its behaviour under the rude strains of weaving, dyeing and cloth-finishing.

Silk producers question the right of articles made from cellulose to the title of artificial silk, and particularly resent the use of the now common abbreviation "art silk." No such proprietary interest is seriously menaced by a material lately

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introduced into this country under the name of artificial wool. In point of fact it is neither wool nor artificial, although certain resemblances to wool cannot be denied. In curl, length of staple, and lustre this new preparation of jute passes easily for wool at a little distance. The colour is a golden brown naturally, but after bleaching, the material is like enough to scoured wool in colour. The harshness, brittleness, and sadness of the material proclaim its vegetable origin to the hand. It can be intermixed readily with wool by the carding processes, and blankets made half of "artificial" and half of animal wool are barely distinguishable from all-wool blankets at sight. There remains, however, the all-important question of cost, and at the price at which the prepared jute is offered, a large selection can be had of raw materials which originated with the sheep, although they may have served in some form of manufactures subsequently. Woollen wastes and shoddy are so various and abundant that the opportunities of replacing them profitably are naturally small. Any wool substitute, to realise a high price, must be capable of use in the worsted industry. Given a fibre which could be intimately intermixed and drawn into a perfect sliver in company with the longer worsted wools, there would be room for exacting a higher price than owners of carding-engines and mule-frames are likely to pay.

The worsted industry is incapacitated from the employment of the great rag reserves, which form a larger bulk of available textile material than is always realised. Exact particulars of the dimensions of the woollen rag industry are wanting, but it is known that the imports into this country have been in the last two years respectively 59,000 and 56,000 tons, entered at an average value of about £19 2*s.* 6*d.* per ton. The number of rag-pulling machines existent in 1904 is also known, and, making the safe assumption that the nine hundred machines treat not less than two tons a week, a British consumption of 90,000 tons per annum can be calculated. The probability that the number of machines has increased, and the certainty that in busy times the machinery runs longer hours, are both disregarded in arriving at this minimum total. A foreign supply approximating to one thousand tons a week is no new thing in Dewsbury experience, and in and about that place substantially the whole bulk is worked. Cheap rags give cheap tweeds and costume cloths, cheap meltons, serges, president and beaver cloth, and make possible the export of as great a quantity as the ninety-eight million yards of last year. It is an odd feature of the English rag trade that the United States should have become the principal source of supply. Rather more than one-third of the imported rags of 1911 were of American origin, and these 19,123 tons may be compared with the 8,815 tons of two years previously, although not directly with totals before that date. There were no imports from America of sufficient importance to be separately recorded before 1909.

Price maintenance is a term little heard within the great body of textile industry. The industries are too little concerned with proprietary names, small specialities, and advertising, to think much of the prices their products ultimately fetch or of the sufficiency of the profit left to the retailer. The announcement that J. and P. Coats, Ltd., the head of the sewing-cotton trade, are to take their customers' opinions on the desirability of stereotyping the retail price of reels of thread, makes easily the most important textile departure in this direction. It is apparent that many drapers have in the past sold thread at prices leaving no profit to themselves, and there is scarcely a doubt that the manufacturers could enforce the maintenance of standard selling prices. The accusation that the great Paisley company holds a monopoly has always been rejected, but in the textile industries no undertaking holds dominion over manufacture in so many lands and none discloses equal profits. The lead would be as important as all the new measures of so great a concern must be. Who would—even who could—follow in a similar way can hardly be guessed at the present time. By far the greater bulk of textile goods are not turned out from the mill in a condition ready for immediate consumption, and bear no definite indication of the manufacturer's identity.

CORRESPONDENCE.

THE ETYMOLOGY OF AGAR-AGAR, "PAW-PAW," AND "CHASUM."

In the last number [February 23rd] of our *Journal*, several English trade names of foreign economic productions occur, a knowledge of the etymology of which is very necessary for a proper understanding of the nature of the commercial articles to which they have been given.

1. *Agar-agar*, so misleadingly synonymed in commerce "Japanese *Isinglass*," is the correct Malayan name, meaning "sea-weed," of *Gracilaria lichenoides*, N. O. Algae [the substance of which is amylaceous, and quite indigestible, and not gelatinous, as is that of isinglass], and other species of Algae; their chief use in this country being in the preparation by bacteriologists of "culture media."

2. "Paw-paw" is an exceedingly sluggardised corruption I have never seen, or heard of, before, of the Malayan name, *papaya*, of the subarborescent palmoid, and herbaceous perennial Passion-flower, *Carica Papaya*, of South America; acclimatised in the gardens of tropical Africa, and all southern Asia, by the Portuguese, in the course of their earliest navigations, conquests, and commerce throughout the East. All its Indian names are corruptions of its Malayan name, and as none of them has an Indian meaning, I assume that its Malayan name may be a corruption of its native South American name. Waller refers to it and its castor-oil-plant-like leaves, and "lovely [pepo-like] fruits," under the name of *papaw;*

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but whether on the authority of travellers in the Americas or in Asia I do not know. The plant is a great ornament of Indian gardens, with its palm-like growth, and wreathed crown of cucurbitaceous leaves, and its melon-like fruits clustered below them; but its fruits, although beautifully moulded, and soft as butter, are very insipid, and a little unpleasant in flavour, while its pungent seeds and sub-acrid milk-like juice, necessitate its being handled with care in the eating of it. I was one of the first to draw attention in this country, through the late Mr. Daniel Hanbury, to its seeds and its juice, both of the fruit and the leaves; and they are now largely used here in the preparation of Papain, or Papayotin. The Anglo-Indian names are "Papaya," "Papay-Mango," "Castor Tree" from its leaves, and "Melon Tree" from its fruit.

3. "Chasum," occurring in my remarks on Mr. Frank Warner's lecture, cannot be an Indian name of any sort, condition, or form of silk. In Bombay it is one of the vernacular names of "gram" [Portuguese *grao*, out of the Latin "granum"], *i.e.*, the "Chick-pea" ["small," "young"-pea, cf. chickabiddy], *Cicer arietinum*; and again, pronounced quickly, *chas'm*, it means the "Evil-Eye." Compare Chas'mah-i-bad, the name of a spring in Khorassan, which, when it becomes polluted, is buffeted by a strong wind until it runs pure again [Job xxxvii. 21]. This word, in its use in the silk industry, utterly baffles me, and I adventure the explanation that it is an immortalised typographical error for the word *Rashum* [with a capital R], the Hindustani name of the silk waste from reeling, etc., used in the weaving of inferior carpets in India.

GEORGE BIRDWOOD.

THE ROYAL COLLEGE OF ART.

The *Journal* of February 9th has a review of Mr. C. R. Ashbee's book, "Should we Stop Teaching Art?" Both he and the reviewer make use of statistics presented in the Board of Education's Committee's Report upon the Royal College of Art. For some years before 1908 I was in close official touch with that institution, taking part in its reorganisation during the years 1899 and 1900. Its future is still a matter of interest to me. Now, the statistics published with the report gave the Committee the impression that of some 450 students who passed through the College courses during a recent period of ten years, thirty-two only have made the practice of art in any form their livelihood, while 136 other students have become teachers, and 230 other past students' occupations are returned as unknown.

The inaccuracy of these figures was the subject of a letter that appeared in the *Times* on November 7th, 1911. I have good reason to believe that the number of the past students referred to, and who are now engaged in the practice of art and of teaching, is at least 390, and that of the balance of sixty unaccounted for inquiry would show that some retired before completing their course of instruction, some died, and that the remainder—say thirty only—have taken up pursuits other than art. Hence, the number of students unaccounted for cannot be over 50 per cent., as shown in the official statistics, but something between 5 and 6 per cent., so that contentions founded on an unaccountability of over 50 per cent. become of extremely doubtful value.

Under the dispensation which has succeeded that of the late Secretary of the Board of Education, who was responsible for the preparation of the statistics put before the Committee, rectification, if it has not already been taken in hand, will no doubt be made.

Meanwhile, it is a pity that the Committee's Report, in so far as it is flavoured by the suggestiveness of inaccurate statistics, should be taken seriously, as for instance, when many passages were quoted from it in the course of the otherwise admirable paper read by Mr. Frank Warner at the Society's meeting on Wednesday, the 21st February last. It is obviously good to consider and discuss how the usefulness of the Royal College of Art in prosecuting its purposes within a well-defined scope may be developed, but there seems to be little advantage in the repetition of polished phrases having the guise of *ex cathedra* pronouncements conveying wholesale condemnation which is found to spring from "otiose conjecture," stimulated by inaccurate statistics.

Clearly, an important committee should not have been provided with misleading materials.

ALAN S. COLE.

OBITUARY.

COLONEL SIR JAMES BUCKINGHAM, C.I.E.—Sir James Buckingham died at his residence in Ashley-gardens on February 27th. He was born in 1843 at Doddescombsleigh, South Devon, and was educated at Blandford Grammar School and Cheltenham College, where he distinguished himself especially in all forms of sport. When he competed at an athletic meeting at Torquay at the age of twenty-three he won all the events. Shortly after this he went out as an assistant on the Torehut tea estate, Assam, and subsequently was appointed manager of the Angoorie estate, a post which he held for thirty-five years. He was recognised as a high authority on all matters affecting the tea industry. For many years chairman of the Assam branch of the Tea Association, he was a member of the Supreme Legislative Council in 1893–4, and again in 1899–1901, being on the latter occasion specially appointed by Lord Curzon's Government in connection with the measure to amend the law relating to the importation of indentured coolie labour which had the chief place in the programme of the Calcutta Session of 1901. He served on the Select Committee, and had a substantial share in bringing about the compromise on the question of wages whereby the conflict between Sir Henry Cotton, the Chief Commissioner, and the planters was in some degree adjusted. On several occasions he

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submitted valuable memoranda to Government on various aspects of the labour problem and other matters of importance. Another service he rendered the industry was his discovery about 1884 of the value of the leguminous *sau* tree (*Allizzia stipulata*) on the estates of the Assam Valley as a fertiliser and a protective agent against insect pests.

Mr. Buckingham did much to promote and develop the Volunteer movement in Assam. About 1884 he raised and became commandant of the Sibsangur Mounted Rifles, which six years later was enlarged into the Assam Valley Light Horse and Administrative Battalion. He was made a C.I.E. in 1890, and from 1895 to 1898 he was honorary A.D.C. to the Viceroy, Lord Elgin.

When he retired from Assam in 1906 he received the honour of knighthood, and on being appointed secretary of the Indian Tea Association here in June, 1906, he did much to extend the range of its activity and usefulness. He joined the Royal Society of Arts in 1908.

George Attwood, M.Inst.C.E., F.G.S., F.C.S.—Mr. George Attwood died at his residence, Steyning Manor, Somerset, on February 9th. Born at Carlisle in 1845, he was educated at Edward VI.'s Grammar School, Lichfield, and a the age of sixteen he began his professional career under his father and Mr. W. W. Palmer in California and Nevada. He constructed large engineering works both in America and in Africa, and he practised as a consulting civil and mining engineer in London. He also published numerous scientific papers. He joined the Royal Society of Arts in 1881. He was a member of various other scientific and professional bodies, and a Justice of the Peace for British Columbia.

George Edward Pritchett, F.R.I.B.A., F.S.A.—The death has occurred of Mr. G. E. Pritchett, of Oak Hall, Bishop's Stortford, in his eighty-eighth year. Mr. Pritchett was the oldest Carthusian, and was present at the recent tercentenary banquet. He was the architect of a number of churches in Hertfordshire and Essex. He became a member of the Royal Society of Arts in 1873.

NOTES ON BOOKS.

The Groundwork of British History. By George Townsend Warner, M.A., and C. H. K. Marten, M.A. London: Blackie & Son, Ltd. 6*s*.

This book has been designed to meet the requirements of middle and upper forms in public schools. The first part, from 55 B.C. to 1603, is the work of Mr. Warner, Master of the Modern Side at Harrow; the second, which carries us up to 1911, is by Mr. Marten, Assistant Master at Eton. In writing the work, the principal object of the authors has been to impress upon the boy "some idea of the origin and sequence and relation of events," to give him some notion of history as a whole. "Our aim"—to quote the preface—"is to provide the reader with a groundwork, at once solid and broad-based, upon which increasing knowledge may gradually be built; to trace out the main threads of British history, omitting small and unfruitful details; to treat events in logical sequence by pursuing one subject at a time; and to concentrate the mind upon what was the chief policy or course of action in each age."

In other words, the authors have endeavoured to treat history in a rational manner, and thereby to encourage the faculties of understanding and reason rather than mere memory. There can, of course, be no question that this method is the right one, and that by this method alone can history be made a profitable study. If a boy has in his mind a reasoned groundwork of events, and knows their why and wherefore, he cannot produce "those grotesque onslaughts upon chronology and probability with which we are all acquainted."

How far it may be possible to interest youthful students in such subjects as scientific progress, artistic and literary changes, industrial advances and social development, it may be hard to say, but without too severely criticising the method of our two accomplished authors, it may perhaps be suggested that they might have experimented a little further in this direction than they have cared to do, especially in the latter part of the book. A chapter of less than twenty pages, "The Industrial Revolution and Social Progress,", is all that is allotted to the history of the social, scientific, economic, and industrial changes that have taken place since 1750. It is, of course, utterly impossible even to summarise within these limits the events of an era in which such profound alterations were made in all the conditions of human life by the development of scientific knowledge and its innumerable applications to human needs. Nor are the statements made always accurate or even intelligible. Watt did not "produce . . . the first efficient steam-engine." Such a statement as, "At first the steam-engine had only a vertical motion . . . later, however, was discovered the possibility of a rotatory and parallel motion," could not have been made by anybody having the most elementary mechanical knowledge, and it is a pity that it should be admitted into a book of this sort. It is, however, fair to say that there are not many similar passages to be found, and after all this one is perhaps due to the carelessness of a scholar writing about technicalities. The fault is extreme compression. But what is a historian, however accomplished, to do who tries to squeeze the history of invention from Kay to Marconi, of periodical literature from Defoe to Delane, of science from Cavendish to Darwin, of medicine from Sydenham to Lister, of industrial economics from Elizabeth's Act to the Workmen's Compensation Acts, of the Post Office from Palmer to Rowland Hill—to mention a few out of many topics—into twenty small pages?

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A paragraph of a dozen lines is all that can be spared for the literature and art of the eighteenth century, while exactly half that amount is deemed sufficient for that of the nineteenth.

It may, however, appear ungracious to dwell on the defects of a useful and compendious history, but the authors in their preface lead us to expect a rather fuller treatment of social matters, as distinct from political, than is actually to be found in their pages. Perhaps the expectation was unreasonable, and the reviewer should have been content to express his admiration for what the authors have really provided—an excellent and well-written history of England from the earliest times to the present day.

Grants in Aid: A Criticism and a Proposal. By Sidney Webb. London: Longmans, Green & Co. 5*s*. net.

Municipal Origins. By Frederick H. Spencer, LL.B. London: Constable & Co., Ltd. 10*s*. 6*d*. net.

The History of Local Rates in England. By Edwin Cannan, M.A., LL.D. Second Edition. London: P. S. King & Son. 2*s*. 6*d*.

These three volumes all form part of the excellent series of monographs by writers connected with the London School of Economics, edited by the Director, the Hon. W. Pember Reeves.

Mr. Sidney Webb makes an interesting inquiry into the history and distribution of our grants in aid. Their whole development, he states, has taken place since 1832. "In 1830 the total payments from the national exchequer to such local authorities as then existed, which were mostly odds and ends of historical survivals, seem to have been insignificant, in fact, considerably under £100,000 . . . In 1870 I gather the total may have been nearing two millions." By 1880 it had reached what was then thought the colossal sum of five millions. By 1910 it exceeded sixteen millions; for 1911-12 it will probably reach something like thirty millions, and "by 1920, when the total revenue of the national Government will probably exceed £200,000,000, the Chancellor of the Exchequer of the day will find himself paying away to the local authorities as much as a quarter of all he receives, or fifty millions sterling."

It will be seen that the problem dealt with is vast and important. Mr. Sidney Webb is not opposed to the system of grants in aid, *per se;* he only objects to it as it at present exists, and he desires to see some intelligent and intelligible principle in place of the haphazard rule of thumb which at present manages or mismanages it. "Any competent revision," he says, "on scientific lines of the financial relations between local authorities and the Exchequer could hardly fail to mean (*a*) a great advance in public health administration in backward districts, especially as regards phthisis, maternity, and infancy; (*b*) a further onward stride in education, including medical treatment and provision of what is required for necessitous children; (*c*) extensive developments in the case of the feeble-minded and mentally defective; and (*d*) a quickening of the whole local administration."

Mr. Spencer's volume gives, as its sub-title explains, an account of English private bill legislation relating to local government from 1740 to 1835. The work is commended by Sir Edward Clarke, in a preface, as "the best and most complete account that I have yet seen of the beginnings of that system of local government and administration of which England is very justly proud." In many cases these beginnings are exceedingly obscure. The journals of the Commons or the Lords throw little light upon them, and as a general rule the minutes of vestries are the main source of our information. Mr. Spencer appears to have been at immense pains in gathering his materials, and his book contains a fund of information which is now brought together for the first time, and which should prove of great service to all interested in the subject.

Professor Cannan's volume, when it first appeared, formed No. 1 of the series of the London School of Economics. It has now been considerably enlarged, the principal additions being Chapters VI., VII., and VIII., in which he discusses the struggle to shift some of the expenses borne by local rates on to national funds, the equity of local rates, and their economy.

An Elementary Text-Book of Coal-Mining. By Robert Peel. Sixteenth Edition. London: Blackie & Son, Ltd. 3*s*.

The fact that this well-known text-book has reached its sixteenth edition is a sure proof of its continued popularity. In the present edition the author has added a chapter on Coal-cutting by Machinery, while the work generally has been revised and brought up to date. For instance, Mr. Peel gives an account and an illustration of the Cunynghame-Cadman Gas-detecting Device, which was first described by Sir Henry Cunynghame in the paper on "Methods of Detecting Fire-damp in Mines," which he read before the Society in November, 1910.

Practical Chemistry for Engineering Students. By Arthur J. Hale, B.Sc. London: Longmans, Green & Co. 3*s*. net.

The scope of this book is clearly indicated by its title. Mr. Hale (who is Lecturer and Demonstrator in Chemistry at the City and Guilds Technical College, Finsbury, and is, therefore, specially familiar with the chemical requirements of engineering students) has laid down a scheme of practical laboratory work in which he deals mainly with what may be called "engineering" materials. Most of the experiments described are quantitative, and treat more especially of such problems as the analysis of water, fuel, furnace gases, iron, steel, oils, cements and alloys. An introductory note is contributed by Professor Meldola, in which he discusses the importance of a knowledge of chemistry to an engineer.

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MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

March 6.—T. Thorne Baker, "Some Modern Problems of Illumination: The Measurement and Comparison of Light Sources." James Swinburne, F.R.S., will preside.

March 13.—Professor Ernest A. Gardner, M.A., "Greek Sculpture."

March 20.—F. Martin Duncan, "The Work of the Marine Biological Association." P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., will preside.

March 27.—Theodore E. Salvesen, "The Whaling Industry of To-day."

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

April 25.—Sir John O. Miller, K.C.S.I., "The Central Provinces."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

March 26.—Leonard Lovegrove, "British North Borneo."

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Cantor Lectures.

Monday evenings, at 8 o'clock:—

Luther Hooper, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

Syllabus.

Lecture II.—March 4.—*The Handloom for Automatic Weaving, Plain and Ornamental, and the Modern Spindle.*—Leonardo da Vinci's sketch of the spinning wheel *flier* and *bobbin* attachment—Its general adoption in Europe for hand spinning—Varieties of the motion developed—Inventors of spinning machinery—Hargreave's *Jenny*, Arkwright's *Waterframe*, Crompton's *Mule*, and others—Weaving in ancient China—Horizontal looms—Indian looms—Old English and other looms for silk weaving—Chinese silk loom—Invention of satin weaving—Looms for weaving small designs—Double *harness* weaving—Long- and short-eyed *leashes*—Chinese *draw-loom*—The *comber board*, its great importance—The *pulley box*—The tail of the loom—The *simple*—The *tie-up* of the design—The *divided* comber board and other arrangements for *tissue* weaving—European draw-looms—Examples of draw-loom woven textiles of various periods.

Lecture III.—March 11.—*The Modern Loom for Plain and Ornamental Weaving and its Future Development.*—Eighteenth century inventions compared with those of earlier periods—The drawboy—The drawboy machine—The Jacquard machine or *draw-engine*—Kay's *fly shuttle*, its great utility and unexpected value—The first power-looms—Application of steam power to the loom—General adoption of the factory system in textile industries—Comparison of hand and power-looms as regards quality and speed of weaving—The effect of machine weaving on the workers—Defects of the power-loom—Electricity as applied to the loom—The loom of the future.

Noel Heaton, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

Howard Lectures.

Monday evenings, at 8 o'clock:—

Captain H. R. Sankey, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

Dates to be hereafter announced:—

Charles C. Allom, "The Development of Artistic Skill in the Applied Arts."

Ernest Kilburn Scott, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

E. D. Morel, "British Rule in Nigeria."

Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

George Fletcher, "Technical Education in Ireland."

William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

MEETINGS FOR THE ENSUING WEEK.

Monday, March 4...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Luther Hooper, "The Loom and Spindle: Past, Present and Future." (Lecture II.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. Henry C. Adams, "The Trolley Vehicle System of Rail-less Traction."

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Dr. C. E. Kenneth Mees, "The Photographic Process." 2. Dr. J. Gordon Parker and Mr. J. R. Blockey, "Notes on the Estimation of Glucose in Leather."

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Victoria Institute, 1 Adelphi-terrace, W.C., 4.30 p.m. The Bishop of Down, "Difficulties of Belief."

Aeronautical, at the Royal United Service Institution, Whitehall, S.W., 8.30 p.m. Lieutenant C. M. Waterlow, "Military Airships."

TUESDAY, MARCH 5...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Roman Studies, Society for the Promotion of, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Professor F. Haverfield, "Some Problems of Roman Gaul."

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. G. Coker, "Optical Determination of Stress, and some Applications to Engineering Problems." (Lecture II.)

Alpine Club, 23 Savile-row, W., 8.30 p.m.

Royal United Service Institution, Whitehall, S.W., 4 p.m. Anniversary Meeting. Report of Referees on Millitary Essays for 1911.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Professor J. Goodman's papers, "Roller and Ball Bearings," and "The Testing of Anti-Friction Bearing Metals."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. J. W. Lumb, "On the Desirability of the Formation of a British School of Pictorial Photography."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. H. L. Hawkins, "The Classification, Morphology, and Evolution of the Echinoidea Holectypoida.' 2. Mr. H. G. Plimmer, "Blood Parasites found in the Zoological Gardens during the four years 1908–1911." 3. Dr. G. O. Sars, "Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1906. Report on some Larval and Young Stages of Prawns from Lake Tanganyika." 4. Dr. Robert Broom, "On the Structure of the Internal Ear, and the Relation of the Basi-cranial Nerves in *Dicynodon*, and on the Homology of the Mammalian Auditory Ossicles."

WEDNESDAY, MARCH 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. T. Thorne Baker, "Some Modern Problems of Illumination: the Measurement and Comparison of Light Sources."

Automobile Engineers, 13, Queen Anne's-gate, S.W., 8 p.m. (Graduates' Section.) Mr. N. V. Page, "Maximum Power for Minimum Weight."

Public Analysts, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., 8 p.m. 1. Mr. H. S. Shrewsbury, "A Method of Estimating Calcium Carbonate in Soils." 2. Mr. A. C. Chapman, "Standards for Malt Vinegar." 3. Messrs. G. D. Elsdon and Norman Evers, "The Estimation of Ammonia in Carbonated Waters." 4. Mr. George A. Stokes, "A Note on a New Preservative for Milk, Cream, etc."

Royal United Service Institution, Whitehall, S.W., 3 p.m. Lieutenant-Colonel E. C. Carter, "The New Transport System, its Principles and their Application."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. Aymer Vallance, "Old Bridges in England and Wales."

THURSDAY, MARCH 7...British West African Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. Mrs. Mary Gaunt, "British West Africa."

Royal, Burlington House, W., 4.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Professor Percy Groom, "Internodes of *Calamites*." 2. Miss Ethel M. Phillips, "Coloured drawings of Barbados plants." 3. Mr. E. A. Newell Arber, "On *Psygmophyllum majus*, sp. n., from the Lower Carboniferous Rocks of Newfoundland, together with a Revision of the Genus and Remarks on its Affinities." 4. The Rev. T. R. R. Stebbing, "Historic Doubts about *Vaunthompsonia*." 5. Dr. Otto Stapf, "Living specimens of Cactoid Euphorbias from South Africa (exhibited by permission of the Director, Royal Gardens, Kew)."

Chemical, Burlington House, W., 8.30 p.m. 1. Mr. A. Angel, "Isomeric Change of Diacylanilides into Acylaminoketones. Transformation of dibenzoylparachloro- (and Parabromo-) aniline into the Isomeric Benzoylchloro- (and Bromo-) amino Benzophenone." 2. Messrs. N. Bland and J. F. Thorpe, "The Chemistry of the Glutaconic Acids. Part III. — Glutaconic Acid and its β-elkyl Derivatives." 3. Messrs. W. J. Pope and J. Read, "Asymmetric Quinquevalent Nitrogen Compounds of Simple Molecular Constitution." 4. Mr. M. N. Banerjee, "The Interaction of Phosphorus and Potassium Hydroxide Solution." 5. Messrs. M. O. Forster and J. C. Withers, "The Triazo-group. Part XX. — Azomides of the Propane Series." 6. Mr. F. L. Pyman, "The Synthesis of Glyoxaline Derivatives allied to Pilocarpine." 7. Mr. H. S. Taylor, "Calcium Nitrate. Part I.—The Three-component System: Calcium Nitrate, Nitric Acid, Water at 25°." 8. Messrs. H. Bassett, Jun., and H. S. Taylor, "Calcium Nitrate. Part II.—The Two-component System, Calcium Nitrate, Water." 9. Mr. F. B. Thole, "Viscosity and Association. Part II.—The Viscosity of Geometrical Isomerides." 10. Mr. J. F. Thorpe, "The Chemistry of the Glutaconic Acids. A Correction." 11. Messrs. A. C. Sircar and E. R. Watson, "Azo-salicylic Acid and Azo-oxy-naphthoic Acid Dyes." 12. Mr. G. B. Neave, "The Catalytic Action of Copper at 300° C. on some Alcohols of the Terpene Group."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Charles Oman, "Wellington's Army." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. F. Enoch, "Fairy Flies and their Hosts."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. W. W. Lackie, "Tariffs for Electrical Energy, with Particular Reference to Domestic Tariffs."

FRIDAY, MARCH 8...Architects, Society of, 28, Bedford-square, W.C., 8 p.m. Mr. A. A. H. Scott, "The Testing of Materials."

Cyclists' Touring Club, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 9 p.m. Dr. A. W. Ward, "The Effects of the Thirty Years' War."

Malacological, Burlington House, W., 8 p.m. 1. Rev. A. H. Cooke, "The Distribution and Habits of *Alopia*, a subgenus of *Clausilia*." 2. Mr. H. Hannibal, "A Synopsis of the recent and tertiary Freshwater Mollusca of the Californian Province. Part I.—*Pelecypoda* and *Palmonata*." 3. Major M. Conolly, "Note on the existence of two editions of Férussac's 'Tableaux Systématiques.'" 4. Mr. E. A. Smith, "Note on *Pleurotoma bipartita* Smith."

Royal Astronomical, Burlington House, W., 5 p.m.

British Foundrymen's Association, Cannon-street Hotel, E.C., 8 p.m. Mr. H. Brearley, "Steel Castings."

Physical, Imperial College of Science, South Kensington, S.W., 8 p.m.

Medical Officers of Health, Society of, 1, Upper Montague-street, W.C., 5 p.m. Dr. G. A. Auden, "Open Air Schools."

SATURDAY, MARCH 9...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Molecular Physics." (Lecture III.)

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Journal of the Royal Society of Arts.

No. 3,094. VOL. LX.

FRIDAY, MARCH 8, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 11th, 8 p.m. (Cantor Lecture.) LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." (Lecture III.)

WEDNESDAY, MARCH 13th, 8 p.m. (Ordinary Meeting.) PROFESSOR ERNEST A. GARDNER, M.A., Yates Professor of Archæology, University College, London, "Greek Sculpture." LORD SANDERSON, G.C.B., K.C.M.G., Chairman of the Council, will preside.

THURSDAY, MARCH 14th, 4.30 p.m. (Indian Section.) E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911." The paper will be read by MR. J. D. ANDERSON, M.A., I.C.S. (retired). SIR THEODORE MORISON, K.C.I.E., M.A., will preside.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, March 4th, MR. LUTHER HOOPER delivered the second lecture of his course on "The Loom and Spindle: Past, Present, and Future."

The lectures will be published in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1912 early in May next, and they therefore invite members of the Society to forward to the Secretary on or before Saturday, March 30th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Michael Faraday, D.C.L., F.R.S., "for discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, etc., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I., "for services rendered to Arts, Manufactures, and Commerce by the realisation of the Suez Canal."

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the Department of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him

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to Arts, Manufactures, and Commerce in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential services in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S., "on account of the signal service rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science to industrial pursuits."

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, "for eminent services rendered to the Industrial Arts by his investigations in organic chemistry, and for his successful labour in promoting the cultivation of chemical education and research in England."

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., "for his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silkworms and domestic animals, whereby the arts of wine-making, silk production, and agriculture have been greatly benefited."

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., "for the eminent services which, as a botanist and scientific traveller, and as Director of the National Botanical Department, he has rendered to the Arts, Manufactures, and Commerce by promoting an accurate knowledge of the floras and economic vegetable products of our several colonies and dependencies of the Empire."

In 1884, to Captain James Buchanan Eads, "the distinguished American engineer, whose works have been of such great service in improving the water communications of North America, and have thereby rendered valuable aid to the commerce of the world."

In 1885, to Mr. (afterwards Sir) Henry Doulton, "in recognition of the impulse given by him to the production of artistic pottery in this country."

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham), "for the services he has rendered to the textile industries, especially by the substitution of mechanical wool combing for hand combing, and by the introduction and development of a new industry—the utilisation of waste silk."

In 1887, to HER MAJESTY QUEEN VICTORIA, "in commemoration of the progress of Arts, Manufactures, and Commerce throughout the Empire during the fifty years of her reign."

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S., "in recognition of the value of his researches in various branches of science, and of their practical results upon music, painting, and the useful arts."

In 1889, to John Percy, LL.D., F.R.S., "for his achievements in promoting the Arts, Manufactures, and Commerce through the world-wide influence which his researches and writings have had upon the progress of the science and practice of metallurgy."

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S., "for his discovery of the method of obtaining colouring matter from coal tar—a discovery which led to the establishment of a new and important industry, and to the utilisation of large quantities of a previously worthless material."

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S., "in recognition of the manner in which he has promoted several important classes of the Arts and Manufactures, by the application of Chemical Science, and especially by his researches in the manufacture of iron and of steel; and also in acknowledgment of the great services he has rendered to the State in the provision of improved war material, and as Chemist to the War Department."

In 1892, to Thomas Alva Edison, "in recognition of the merits of his numerous and valuable inventions, especially his improvements in telegraphy,

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in telephony, and in electric lighting, and for his discovery of a means of reproducing vocal sounds by the phonograph."

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S., "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted."

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries, by which not only has the art of surgery been greatly promoted, and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his metallurgical researches and the resulting development of the iron and steel industries."

In 1896, to Professor David Edward Hughes, F.R.S., "in recognition of the services he has rendered to Arts, Manufactures, and Commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

In 1897, to George James Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water-supply and the sewerage of towns a trustworthy basis for their work, by establishing and carrying on during nearly forty years systematic observations (now at over 3,000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S., "in recognition of his numerous and most valuable applications of Chemistry and Physics to the Arts and to Manufactures."

In 1899, to Sir William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics—researches which have, in many instances, developed into useful practical applications in the Arts and Manufactures."

In 1900, to Henry Wilde, F.R.S., "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small—a discovery now used in all dynamo machines—and for its application to the production of the electric searchlight, and to the electro-deposition of metals from their solutions."

In 1901, to His Majesty King Edward VII., "in recognition of the aid rendered by His Majesty to Arts, Manufactures, and Commerce during thirty-eight years' Presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country, and the executive control of British representation at International Exhibitions abroad, and also by many other services to the cause of British Industry."

In 1902, to Professor Alexander Graham Bell, "for his invention of the telephone."

In 1903, to Sir Charles Augustus Hartley, K.C.M.G., "in recognition of his services, extending over forty-four years, as Engineer to the International Commission of the Danube, which have resulted in the opening up of the navigation of that river to ships of all nations, and of his similar services, extending over twenty years, as British Commissioner on the International Technical Commission of the Suez Canal."

In 1904, to Walter Crane, "in recognition of the services he has rendered to Art and Industry by awakening popular interest in Decorative Art and Craftsmanship, and by promoting the recognition of English Art in the form most material to the commercial prosperity of the country."

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S., "in recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S., "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

In 1907, to the Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E., "in recognition of his pre-eminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and, by the initiation of great works, has opened up new fields for enterprise."

In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S., "for his investigations into the liquefaction of gases and the properties of matter at low temperatures—investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

In 1909, to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

In 1910, to Madame Curie, "for the discovery of radium."

In 1911, to the Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S., "for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type, and for his invention of the re-action type of steam turbine, and its practical application to the generation of electricity and other purposes."

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PROCEEDINGS OF THE SOCIETY.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 6th, 1912; JAMES SWINBURNE, F.R.S., M.Inst.C.E., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Ainsworth, Herbert, P.O. Box 1553, Johannesburg, South Africa.

Andrews, Fred Henry, 3, Park-hill, Clapham, S.W.

Bishop, Albert E., 1, Metal Exchange Buildings, Whittington-avenue, E.C.

Dodge, Walter Phelps, The Reform Club, Pall Mall, S.W.

Kothari, Jehengir H., K.I.H., Karachi, India.

Millard, V. C. H., M.A., Shrewsbury House, Ditton-hill, Surrey.

Welch, George Winston, Danville, Kentucky, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Bevington, Alexander, Silverwood, Pyrford, near Woking, Surrey.

Cadogan, Lieutenant Francis Charles, R.N., H.M.S. "Prince of Wales," c/o General Post Office, E.C.

Hussain, Moulvi Ahmed, C.S.I., M.A., B.L, Chief Secretary to H.H. the Nizam's Government, Hyderabad, Deccan, India.

Reinhold, Captain Carl Henry, I.M.S., F.R.C.S.E., 58th Rifles, F.F., Quetta, Baluchistan, India.

Scott, Charles, Rosedale, Bolivar County, Mississippi, U.S.A.

Singh, Baba Mihan, Small Cause Court, Amritsar, India.

The paper read was—

SOME MODERN PROBLEMS OF ILLUMINATION.

By T. THORNE BAKER, F.C.S., F.R.P.S.

During the past two or three years quite a large amount of attention has been paid to the subject of illumination, from more or less new points of view which have been suggested by modern conditions of living and working. Formerly it mattered little whether a candle, an oil lamp, or a Bray's gas-burner were responsible for the lighting of a room, provided only that the illumination were sufficient. Now we require an illumination which must possess the maximum economy, the maximum of diffusion and distribution, and which must be of a colour required by the dictates of hygiene. The means of testing an illuminant, of modifying its light so as to produce an illumination which is physically nearest to what is ideal from the point of view of hygiene, and so on, are few, and are appreciated by the few only who have made this subject a matter for personal attention. I propose to deal briefly to-night with simple ways and means of producing an illumination as nearly resembling daylight as possible, which can be adopted by illuminating engineers and others with a small amount of expense, and which will yet give results of sufficient accuracy to satisfy modern demands.

While so much attention is being paid to the subject of lighting, from hygienic and similar points of view, I think it seems fairly evident that its spectroscopic character should receive due consideration, but up to the present I do not think that the colour of light has been seriously dealt with by more than a few independent workers. We cannot, of course, compare the human body or the human eye with anything else, but it is interesting to note that the effect of colour on living organisms and on vegetable life is in some cases extremely marked. I have a slide here showing how certain bacteria crowd together in specific regions of the spectrum simply because these regions embrace the rays absorbed by the chlorophyll of the algal filaments present in the water, and, by the chemical change produced by this absorbed light energy, obtain the maximum of nutrition. I also showed a few months ago, at the Royal Institution, some remarkable effects of coloured light on the growth of bacteria, and more especially on the formation of pigment by bacteria, and on that occasion I stated the inference that one was led to arrive at—viz., that while the ultra-violet, violet, and orange rays produced marked effects on many families of bacteria, the green-yellow rays in the middle of the visible spectrum were usually without effect. I also showed, from tests made in the laboratory, how by projecting certain specified red rays into an experimental "vat" in which sugar was being fermented by yeast, alcohol was produced with abnormal celerity. A diagram of the apparatus employed is shown on the screen.

These facts tend to show that the artificial light employed for the habitation of human beings should presumably be that to which they are normally accustomed, viz., daylight, and I think that investigations made with a view to

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determine the most suitable light for the eyes will lead to one result only—the demand for a light spectroscopically equivalent to normal daylight.

Whether normal daylight is the best illuminant or not may perhaps be open to argument, but it can hardly but be the case when we consider that man, through being accustomed to sunlight for so many thousands of years, must naturally have become physically adapted to it.

Except in isolated cases of specialisation, the illuminating engineer has not closely associated spectroscopic methods with the practical side of lighting and illuminant testing, though now much valuable work is being done by Dr. Ives and Mr. Luckiesh. I have come across many instances in this country where industrial work has been hampered through the use of artificial light, ideal, perhaps, from the engineer's point of view, but very deficient from the physicist's point. One example, of which there must be many hundreds of cases, was that of a factory where the printing of wallpapers was carried on. Considerable difficulty was always found, especially in winter-time, in the matching and choosing of colours, and it was found that, when the daylight was good enough, the colour matching—of the dyes, etc.—was done by it, whereas in dull weather it was carried out by the light obtained from carbon filament lamps. Considerable discrepancies naturally occurred from this practice, and a special lamp was made, in which I employed metal filament (tungsten) lamps, and a suitable light filter, which gave filtered light spectroscopically equivalent to daylight, so that uniform colour-matching and the accurate selection of dyes and pigments was ensured.

The spectrum of daylight itself varies within quite remarkable limits, as the slide now on the screen will show. You will see here the curves obtained by plotting against wave-lengths the densities obtained on a panchromatic plate on exposure in the spectrograph to sky-light at various times—dull evening summer sunlight, when by atmospheric refraction the light is very yellow, and sky-light with direct sunlight and with the sun obscured by light and heavy clouds respectively.

It is, I think, well agreed that the best standard to adopt is white cloud-light, and we may therefore direct the attempts under discussion to the screening of various forms of illuminants so that artificial illumination physically equivalent to daylight is obtained.

You will now see on the screen a natural colour photograph of the electric arc (open), which shows brightly recorded several of the principal lines. The positive pole has been touched with a solution of a lithium salt in order to give the orange and blue lithium lines, and the sodium lines and a few others are seen as well. Before dealing with the photo-spectrometric method, by which one illumination can be matched with another by a simple trial and error method, I will briefly discuss the analysis of illumination by spectro-photography. You see here two or three different forms of simple spectro-cameras for taking photographs of the spectrum given by the light of any illuminant which is focussed on the slit of the instrument. One of these is arranged with a quartz lens and a hand-feed arc lamp in the correct position for taking a photograph. Suppose, then, that we take a series of photographs on a very evenly sensitised panchromatic plate, of No. 1 illuminant, let us say, open arc, with uncored positive pencil, and then another series of No. 2 illuminant, let us say, carbon filament electric lamp or incandescent gas. On developing the plates under equal conditions, we get two sets of photographs of the spectrum of the two illuminants, and we can,

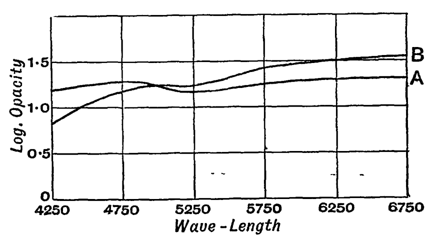

FIG. 1.—DENSITY CURVES OF (A) ARC, (B) TANTALUM LAMP.

by comparing the most suitably exposed spectra in each, find with considerable accuracy the most obvious differences; the slide on the screen will show two such series of exposures, and it will be seen at a glance how relatively rich the arc light is in violet and blue, and how relatively rich the incandescent light is in greenish-yellow and red. A green object will look too bluish-green in the first light, and too yellowish-green in the second, speaking comparatively.

If now we divide these spectrum records into equal divisions, each division being a specific region of the visible spectrum, and measure with a suitable photometer the densities of these regions, and plot them against wave-length, we should obtain two curves which, when compared, indicate the relative spectroscopic character of the illuminants. The results are seen in Fig. 1.

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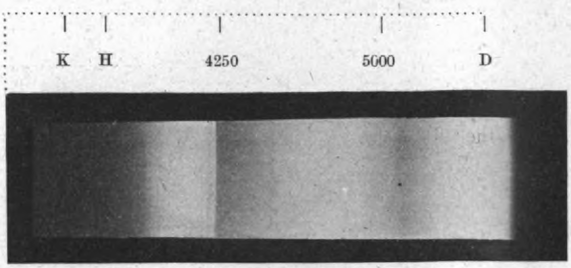
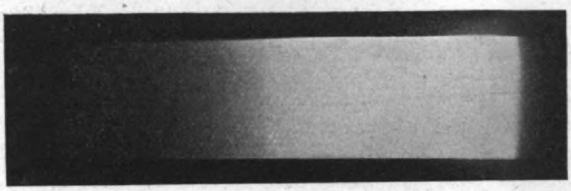
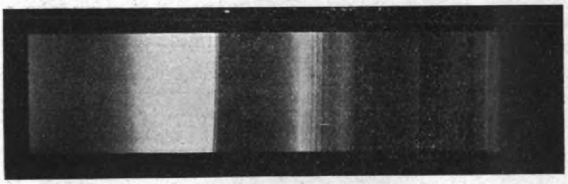
Spectrograph Prints illustrating the Remarks made in the Paper regarding Prism Records.



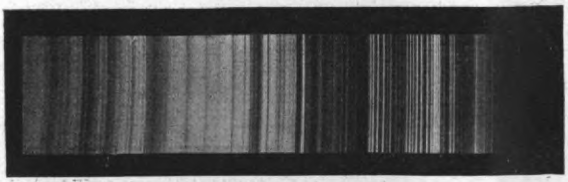
(1) Prismatic Spectrum. Open Arc.



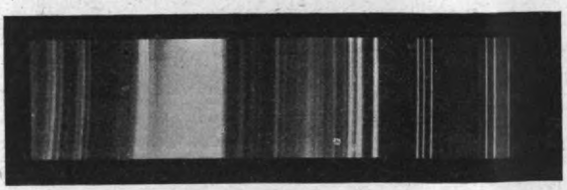
(2) Prismatic Spectrum. Carbon Filament Lamp.



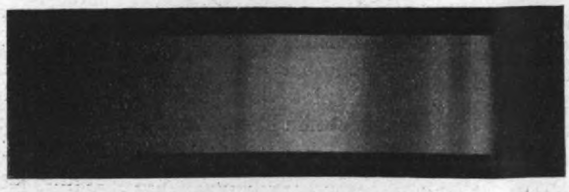
(3) Prismatic Spectrum. Purified Carbons.



(4) Vanadium Arc (Prismatic).



(5) Copper Arc (Prismatic).



(6) Daylight Spectrum (Prismatic).

These results give no definite measurements of the analysis of the illuminants, but they give all the indication requisite on which to base experiments for the production of a screening filter to render the screened illumination No. 2 identical with the illumination No. 1. It is clear that, as No. 2 is deficient in violet, blue, and blue-green, for example, the screen must be blue-violet and slightly green, in order to absorb the over-strong yellow and red rays. After making a liquid filter of this colour and testing the illuminant again with the spectrograph, we shall see how much nearer we have got No. 2 to No. 1. A series of experiments will give the necessary results, and we shall finally, on testing, find the spectra given by arc light and the *screened* incandescent lamp identical. Such a result is now shown on the screen.

This spectrographic method is useful in many ways, and I shall therefore devote a little time, with your permission, to refer to actual apparatus. The most suitable apparatus for this type of light analysis is unquestionably the concave grating spectrograph, as the dispersion throughout the spectrum is proportional to the wave-length. In the prismatic spectrum the ultra-violet and violet-blue regions are well dispersed, whereas the green, yellow, and red regions are all cramped up together, and therefore tend to appear far more luminous than actual measurement shows them to be. Some examples of the use of the prism spectrograph, which I will now show, give a very good idea of the erroneous indications of those records, though the abnormal density in the yellow-red region is to some extent in accordance with the character of the usual direct luminosity curves of the spectrum—not of the logarithmic curves as obtained with the spectrophotometer. The first two slides show respectively prismatic records of the open arc and a carbon filament incandescent lamp. The bands and lines in the former are seen to predominate and appear in an otherwise continuous spectrum, while the excessive amount of yellow and red rays are shown up well in the latter.

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A third slide (3) shows the line spectrum of the positive pole of an arc between purified carbons. The carbon pencils were soaked in pure nitric acid for two weeks, and then in several changes or distilled water for several weeks. The fourth and fifth slides of this series show the spectrum with carbons rendered impure with (4) vanadium chloride; (5) copper chloride, and indicate the importance of pure carbons when screening the arc light in order to minimise the line effect. The sixth slide (6) shows a prismatic spectrogram of daylight, in which the principal Fraunhofer lines are seen.

A diffraction grating illuminated with parallel rays normal to itself gives us for light of any wave-length λ the expression

$$n \lambda = b \sin n \theta,$$

where n is the order of the spectrum, b the width of the rulings of the grating, and θ the angle the viewing telescope makes with the normal, when the line of the wave-length in question occupies the central position of the eyepiece field. Since the first order spectrum is usually employed, we have $\lambda = b \sin \theta$.

Plane grating replicas with about 17,000 lines to the inch are obtainable now of great precision, and more recently concave gratings have been made with success by mounting a celluloid replica on curved speculum metal. The great advantage of the concave grating is that it acts as its own lens, and no lenses are therefore necessary in the camera. Thus the difficulties of selective absorption before the light reaches the plate are obviated. You will see here a small concave grating camera, designed by Mr. Sanger-Shepherd, which will give a 3-inch spectrum of extremely fine definition. If we use a quartz lens for projecting the image of the illuminant on the slit, we can obtain the ultra-violet and blue-violet spectrum, and, by altering set screws at the back of the camera, the grating can be reset for photographing the visible spectrum only. The slide on the screen shows a simple line spectrum (copper and sodium) which is suitable for scaling. One inch on the actual negative represents approximately 1,250 Angström units, and as the dispersion throughout it is proportional to the wave-length, if we have one known line as a datum line, the spectrum can be divided up immediately into specific regions by simple measurement.

For more critical work, a camera attachment to a spectrometer is very useful, and I have here a small spectrometer fitted up in this way with which much of my own experimental work is done. The photographic plate admits of a 2-inch spectrum only, but with a 2-inch dense flint prism a 6-inch spectrum is obtainable, so that we can deal with the spectrum in three separate parts. An Iceland spar or quartz prism (with a corresponding change of course in collimating and telescope lenses) enables us to photograph the ultra-violet region. Very fine definition can be obtained in this way, which is equal to that of far more costly apparatus, while one has the advantage of being able at a moment's notice to remove the camera and place the eyepiece in the telescope for visual work, which, by the way, is frequently required.

Where a prism is employed, it is necessary to prepare a scale from which every desired wave-length can be easily found from its position on the negative. A number of known lines are obtained from either the arc or the oscillating spark from an induction coil with a capacity shunted across the spark-gap. The positions of these lines are then accurately measured with a travelling microscope and plotted against wave-length on squared paper, and the necessary reference curve prepared. By using a flat grating instead of the prism, the dispersion is once again obtained nearly proportional to the wave-length, so that scaling becomes easier. A screen is usually necessary to cut out the ultra-violet portion of the second order spectrum.

It is, of course, open to argument whether a purely photographic method of analysis is preferable to a visual method, but if the tests are carried out in a suitable way, it is, I think, a very satisfactory one. Standard negatives of a standard illuminant, however, cannot be obtained with any great precision unless the most rigid precautions are observed, and a fresh control negative is always desirable with which to compare the negative made with the illumination under consideration. A very evenly colour-sensitised plate is essential, and I know of none better for the purpose than the new Ilford panchromatic, which gives, with the open arc spectrum, an almost uniform deposit throughout. Ordinary plates bathed in a 1:100,000 solution of homocol, containing 2 per cent. of ammonia, also give even colour sensitiveness, but bathing is a troublesome process, and it is, therefore, far preferable to obtain the plates already bathed.

Before leaving this section of the subject, I will show one or two spectrograms made with the spectrometer with camera attachment. The first is of mercury vapour, in which the prominent mercury lines are clearly shown; the second is of neon, to which I shall refer again later.

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The third is a spark spectrum, such as serves for scaling purposes, obtained by focussing on the spectroscope slit the oscillating spark of a 2-inch coil with one quart Leyden jar shunted across the spark gap. By using lead for one electrode and copper for the other, moistened with a solution of lithium chloride, we get several known lines well distributed throughout the spectrum, from which a scale can be readily made.

Dr. Eder has kindly sent me some of his most recent spectrograms, taken with the well-known grating spectrograph in Vienna, and as these are closely connected with the metal filament lamp industry, I am glad to be able to show them to-night. They are as follows:—

1. Erbium nitrate (visible and ultra-violet).
2. Vanadium nitrate (visible and ultra-violet).

(This should find extensive application for arc carbon cores.)

3. Niobium (visible and ultra-violet).
4. Tantalum (visible and ultra-violet).

Apart from the rough qualitative method of comparing two illuminants by having their spectra thrown into juxtaposition with a spectroscope fitted with a comparison prism, the most direct analysis of illumination is by means of the spectro-photometer, an instrument of which there are now several types to be had. Two beams of light can be examined simultaneously, either by the aid of a comparison prism on the slit of the spectroscope, or by means of a prismatic separator such as is used in the Hüfner instruments. One of these beams may be that of a standard light, the other that of the light to be compared with the standard, whilst either one or the other beam may be dimmed by the use of crossed Nicol prisms.

In Dr. H. E. Ives's work, the spectro-photometer has been largely used, and he has dealt in a very practical way with methods of comparing and standardising with daylight various illuminants. He suggests the use of coloured pot-glass, with a supplementary dyed filter to compensate for any narrow absorption bands, as a means of making a filter to produce light spectroscopically equal to daylight; but I do not think this is as practicable as the method of using dyed gelatine by itself, or dyed agar-agar where the heat would be likely to upset a gelatine film. Various useful curves and data obtained by Dr. Ives have been recently published in the *Illuminating Engineer*, and much practical suggestion as to methods of making light filters.

The spectro-photometer (a diagram of Messrs. Hilger's Hüfner apparatus is shown in Fig. 2), gives direct readings of the relative

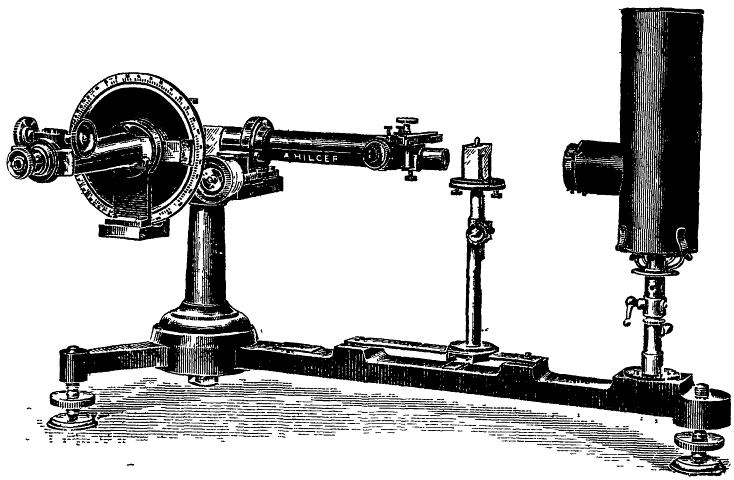

FIG. 2.

intensity of two light sources, which can be measured in successive regions of the spectrum by means of a slit shutter, which screens off all but the region under comparison. The standard beam passes through a Nicol prism, which polarises the light perpendicularly, and it and the beam whose spectrum is to be measured are then thrown on the slit of the spectroscope, so that their spectra are seen in juxtaposition in the eyepiece. The intensity of the spectrum under examination is readily deduced by rotating a second Nicol prism, which extinguishes the standard beam to the desired amount—*i.e.*, until for the narrow region under comparison the two are of equal visual luminosity; the square of the cosine of the angle of rotation of the second Nicol gives the density required.

The Hüfner instrument comprises one of the

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Hilger constant deviation spectrometers, one of which I have here on the lecture table, and those gentlemen who care to examine the helium and neon lines afterwards will, I trust, do so, especially as, through the kindness of Professor

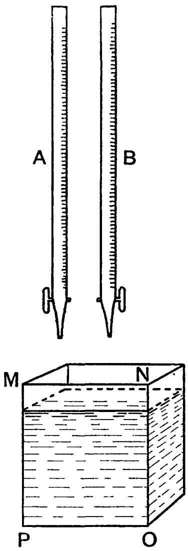

FIG. 3.

Fleming, I am able to show one of the very fine neon tubes made by him at University College. These tubes are of great use in radio-telegraphic measurements, as they are readily excited by high-frequency oscillations, and the nodes and antinodes of the waves produced in antennæ, or the long inductance coils in which stationary oscillations are set up, can be located with accuracy for wave-length determination.

A simple spectro-photometer can be made by employing two Nicol prisms with an ordinary spectrometer fitted with a comparison prism, the polarising Nicol being placed in the optic axis of the standard beam, and the analyser being substituted for the spectroscope eye-piece. If an analyser with a large divided circle be employed, the measurements can be made with a good deal of accuracy. These sets of polariser and analyser are quite inexpensive, and the latter is fitted with a divided drum in many of the sets designed for food analysis. By making an adapting collar, they can easily be fitted to the spectrometer telescope in place of the usual eyepiece. The polariser is merely supported in a stand to lie in the optic axis of the collimator.

A convenient apparatus for the production of a "daylight" or other filter is that shown in Fig. 3. Here *A* and *B* are two burettes (and there may be any number of them) filled with solutions of dyes of known strengths, let us say, 1 per cent. The glass cell through which the rays from the illuminant are screened before falling on the spectroscope slit, is filled with water, the area of which, *MNOP*, is, say, x square centimetres. Trial and error experiments show us that y cubic cm. of the solution in burette *A*, and z cubic cm. of that in burette *B*, give the desired tint to the liquid filter—*i.e.*, colour it so that a beam of light passed through it to the spectrograph or spectro-photometer shows it equal colorimetrically to daylight. We then know that, to prepare a daylight filter for the lamp tested, we require for each square centimetre of surface—

$\frac{y}{100\,x}$ grms. of the dye present in burette A,

$\frac{z}{100\,x}$ grms. of the dye present in burette B,

and so on.

Where light filters are to be prepared on a large scale, pot-fired glass would, of course, be ideal; but if ventilation can be secured, and the filter need not become too hot, a gelatine solution (about 8 per cent. strength), with the necessary dyes incorporated, can be coated on flat rolled plate-glass, the requisite amount of coloured solution being allowed per unit area. The next slide (Fig. 4) shows a contrivance I have made in several instances for industrial work where colour mixing or matching is part of the ordinary routine, with the result that in all weathers, and by day or night, one has standard daylight illumination to work by. A number of metal filament lamps (usually tungsten) are fixed in

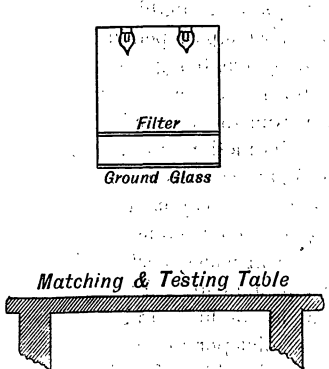

FIG. 4.

the top of a metal box, the top and inside of which is enamelled white. Below them is the gelatine-glass filter prepared in the manner described, from either spectro-photometric or spectro-graphic tests, and below that is a piece

of ground glass to diffuse the rays. The ground glass, by the way, has itself a slight screening effect which has to be taken into consideration. Rays of white "daylight" are then thrown down on the table where the colour-matching is done.

Now, if we were to take ourselves to task systematically, and apply to inverted lights these daylight filters, it would be possible to flood our art galleries and picture exhibitions with natural, normal light, and to place them at the disposal of the public for many more hours a day than we can do at present. Artificial daylight, so essential for the exhibition of pictures, could be obtained not only at night, when there is no real daylight, but at any time of the day in dull weather. The cost is by no means prohibitive. I estimate that to screen tungsten filament light to simulate normal daylight, only a small percentage (two or three)* of it is wasted in absorption by the screening filter, and if these filters were taken seriously in hand by illuminating engineers, we should soon be able to have the light of maximum hygienic properties in all the commercially applicable forms. So much excellent work has been done by electrical engineers in recent years, and so much time and thought spent in producing well-diffused illumination, that it seems a pity to stop short of rendering the light approximately identical with daylight, so that it could be a satisfactory substitute for it.

We come next to sources of illumination provided by the discharge of high-tension currents through vapour or rarefied gases. The mercury vapour lamp is now too well known to need any description, but the Moore and Cooper-Hewitt lamps are probably only the forerunners of many other lamps depending on the luminosity of electrically excited gases, notably neon and helium, both rare gases which can now be extracted from the atmosphere on a commercial scale. A distinction must, of course, be drawn between light produced by incandescent and by arc lamps and vapour tubes, for whereas the former give a continuous spectrum, the latter give spectra in which certain lines or bands or both are prominent. Arc light thus contains several series of lines and bands in the violet and ultra-violet portion of its spectrum, due to cyanogen and oxides of carbon, etc., as well as others in the green, due to nitrogen, etc., and so on. These lines mean that although we appear to have a fairly normal spectrum, we are really letting our eyes be subjected to an excess of certain more or less harmful rays in addition. If many of these rays be isolated, they can be used for bactericidal and therapeutic purposes. Similarly, if a mercury vapour lamp be used with quartz glass, its rays include those in its spectrum which are bactericidal. If, then, we accept normal daylight as the ideal, it is unlikely that we shall ever match it with the illumination from a vapour lamp, though it must be remembered that the sun's spectrum contains, amongst its many thousands of lines, some which are far more marked as regards luminosity than others, or, more correctly, many spaces lighter than the normal between dark lines or series of lines.

The slide next on the screen shows spectrum photographs of a mercury vapour light, and under it the spectra of neon and helium. It will be seen what a number of bright and well-defined lines each one possesses. It is also seen to what an extent the bright green mercury line, which is largely used in physical work as a source of monochromatic light, accounts for the illumination. Similarly, we see the nature of the predominant yellow and red lines in the spectrum of neon. The dielectric strength of neon is about one seventy-seventh that of air—*i.e.*, about seventy-seven times the voltage would be required to break across an air gap as would be necessary in the case of neon. Pure neon is exceedingly luminous when subjected to high-tension discharges, and is likely to prove very efficient as a source of illumination. Some interesting particulars were recently published in *The Electrical Review*, where an abstract of a recent paper by M. Claude was given. Neon is not apparently so scarce as one was originally led to believe, for M. Claude claims to be able to produce as much as one hundred litres of neon in a day, which suffice for the manufacture of one thousand tubes of one thousand candle-power each. The tubes at present made for commercial purposes must be supplied with alternating current, and 3,200 volts is stated to suffice for lighting three tubes in series each six metres in length. The lighting power is about two hundred candles per metre of tube, and the consumption for the luminous portion of the tube is about 0·45 watt per candle.

I have here a small neon tube, from which you will see the colour of the light emitted, as against the helium tube. The rays are a rich golden red, and I believe that, if they were mixed with those from a separate mercury vapour tube, the combined illumination would be very much better than that of either separately. I venture

* In the case of the open arc.

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to predict that by combining tubes in series or in parallel, each filled with a different gas, a combined spectrum will be reached which will be most close to the ideal requirements, and far closer than illumination already obtained tentatively by combining incandescent electric lamps with mercury vapour. I fancy that this method will be better and more economical than the screening of the lamps or the use of fluorescent reflectors. While on this subject, I will take the opportunity of showing the value of the fluorescent reflector which has been produced after so much experiment for the Cooper-Hewitt lamp. You will see by examining the colours on this chart, when it is illuminated by the ordinary mercury vapour lamp, and then by comparing them when it is illuminated with the lamp with the reflector attached, how much nearer the real thing the latter light is. I have only been able to make a limited number of tests with combined spectrum tubes in the laboratory, but from these experiments it appears feasible, by employing two tubes simultaneously whose spectra are in some measure complementary, to obtain a more or less white illumination. A direct confirmation of this will be seen later when dealing with helium light.

A point of interest is that a good deal of a neon or helium vapour tube is useless for purposes of illumination—the portions near the electrodes —and in the case of Claude's neon tubes one metre is non-luminous in a six-metre tube, or one-sixth of the total. The non-luminous portions contain, as a rule, complex spectra entirely different from that of the visually luminous portion, and their ratio to that of the luminous portion becomes less the more we increase the length of tube; hence very long tubes are more efficient for lighting than short ones.

Turning now to helium, we find a gas which offers many attractions both for investigation and for practical use. Rarefied pure helium gas gives an intense light of whitish-yellow hue, somewhat similar to that of the flame of some of the lighter burning oils, and yet spectroscopically it consists merely of a few isolated bright lines, notably two in the red, one in the yellow, one in the green, and two in the blue-violet regions.

These lines are of such wave-length that in combination they present a light which it is difficult to believe does not possess a continuous spectrum. I have here a helium tube, and will show it illuminated by a small induction coil, and you will see what a beautiful quality the light possesses. Despite its apparent whiteness, the spectrogram shows how isolated the component lines are, and yet how evenly distributed throughout the visible spectrum. The yellow line is double, but is so relatively bright that it appears merely as one broad line.

Helium vapour lamps have quite recently been adopted by the Bureau of Standards at Washington as the standard unit of illumination, and one very important point in favour of this choice is the fact that the luminosity of the tube remains constant over quite a wide range of current. It is naturally a great advantage to the observer if a 5 per cent. increase in the current supply of the standard lamp causes no variation in its candle-power. But the apparent colour of the light renders it extremely suitable for comparative purposes, as it is a more or less "happy medium" of paraffin oil gas, flame gas, incandescent gas, and metal filament lamps. For an unfiltered light the open electric arc and the acetylene flame are the nearest approaches

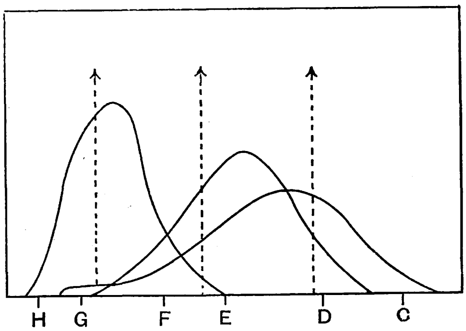

FIG. 5.

to daylight, but, owing to the constancy of the candle-power under varying circumstances of the helium vapour lamp, the latter should prove ideal as a standard light source.

An interesting problem crops up in relation to helium light, which I believe is likely to play an important part in the lighting of the future. Assuming that we are agreed as to the desirability of having a white illumination resembling normal daylight, what will be the effect of having a light white only in appearance, and not actually the result of a continuous spectrum? I have drawn on squared paper an approximate reproduction of Clerk-Maxwell's curves, showing the spectra included by the three primary colours, and have drawn in the position of the brightest helium lines (Fig. 5). You will see at a glance that they occupy positions more or less centrally situated near the maximum of these three curves, one just to the less refrangible side of the *G* line,

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one between F and E, and one slightly more refrangible than the D lines. It is thus quite clear why we get such an apparently pure white light, as by mixing light of the wave-lengths of the maxima of the three curves we should have an apparently pure white light.

The question then comes: Is a white light, due to the mixing of light of three or more wave-lengths, of equal value from a hygienic point of view to white light due to a continuous spectrum? On the assumption that colour vision depends on the actuation of three nerves only, each corresponding to one primary colour, it does not seem unreasonable; yet it is well known that narrowly-defined regions of the spectrum alone have definite therapeutic effects.

I cannot on the present occasion attempt any answer to this interesting problem; the only experiments I have made have been the subjection of bacteria to light of isolated wave-lengths—*e.g.*, the green mercury line and the monochromatic light from a sodium lamp, and no positive results were obtained. There may be some present, however, who can throw some light on the matter, which is one that demands close attention, as since from the efficiency point of view vapour lamps would appear to hold the prospective field, I certainly think the characteristics of helium vapour suggest it as the light of the future.

A helium vacuum tube 7 cm. in length and 2 mm. in bore, with terminal bulbs containing aluminium electrodes 25 mm. in diameter, has been, I believe, decided upon as the standard by the Washington Bureau. The light is found to be constant even over a considerable range of voltage and current frequency, as stated above.

In connection with vapour tubes, several points have to be borne in mind when making any experimental measurement of efficiency. The colour of the luminous discharge of electrons, of course, varies with the degree of exhaustion, and up to a certain point an increase in the exhaustion means decrease in the potential necessary to cause the discharge. Under certain conditions there is definite proof that the colour of the emitted light is partially, though not largely, due to the material of which the electrodes are made, spectrograms having been obtained from vapour discharges, which include lines due to the electrodes. The colour of the glass has a very important effect on the character of the light, owing to the fluorescence of certain types of glass, and a very simple experiment (which I trust the more technically-minded will excuse) shows the two-fold effect of a discharge through rarefied air,

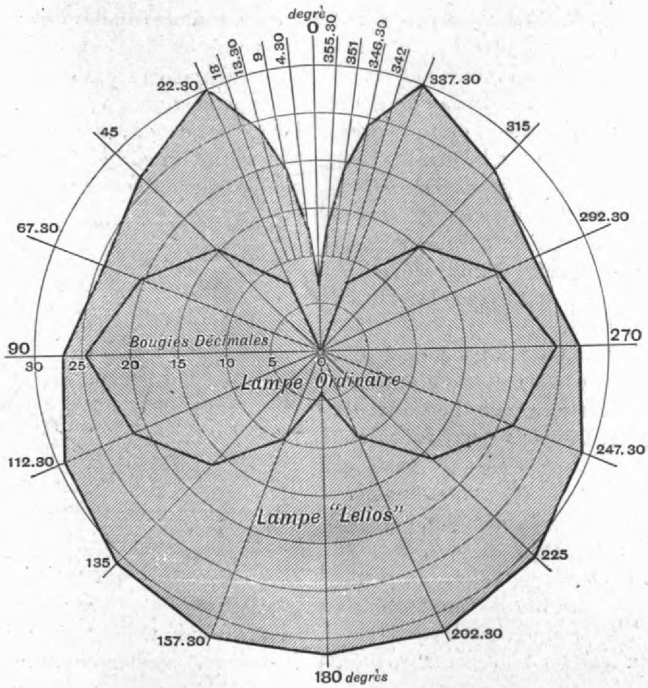

Fig. 6.

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the tubes in one direction being of a different glass from those in the direction at right angles.

I believe that there will be room for great experiment in determining the character of suitable glass for the manufacture of the vapour lamps which are likely to be exploited in the future, and it is fairly obvious that this character will vary according to the vapour being employed.

One of the most important lessons of the helium tube is that, in endeavouring to secure white illumination, an easily obtained isolated spectrum line may do more good than any amount of wide continuous or banded regions.

One feature with which illuminating engineers will have to deal is the effect of the character of the current supplying vapour tubes on the colour of the luminous discharge. It is well a rectifier), it gives a distinct yellow light when used on a high-frequency oscillating circuit.

The commercial neon tubes of Claude, when run on alternating current, can be controlled by means of a series inductance, and the current can be reduced from the normal, about 1·3 amperes, to 0·6 amperes. Here, again, it is observed that the light becomes red with decrease in the current consumption, due to the attenuation or even wiping out of the more refrangible spectrum lines.

There are one or two points of interest I should like to draw your attention to before concluding to-night, in reference to some new work in connection with light distribution. One is a new lamp which emanates from Brussels, in which the (metal) filaments are suspended in a horizontal

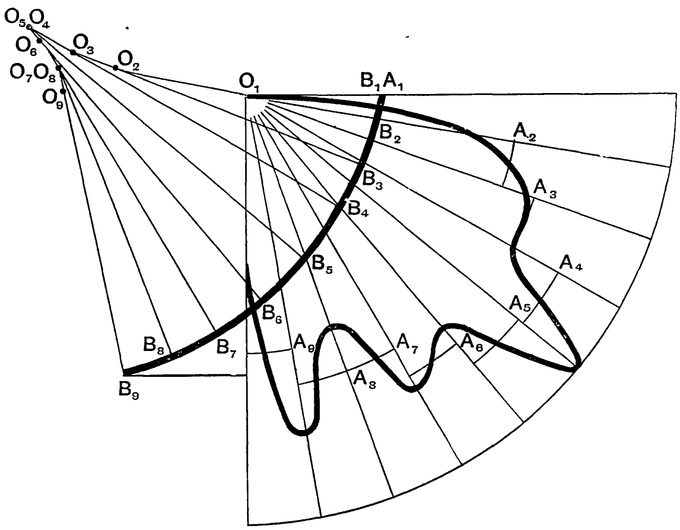

FIG. 7.

known how the spectrum of an oscillatory spark changes when self-induction is introduced into the oscillating circuit, and both self-induction and capacity appear to affect neon and helium tubes. When illuminating the tubes by means of high-frequency oscillatory currents, the higher the frequency the less is there of the violet components in the spectrum of the gas. Thus, while neon emits a good golden light in the ordinary way, the tube being fed from an induction coil, if we feed it with oscillatory currents, the colour becomes a dull red, and the higher the frequency the duller the colour—*i.e.*, the more pronounced are the lines in the red part of the spectrum, compared with the blue-violet, etc. The same is the case with helium, as I shall be able to show. While it emits a beautiful white light with direct current (I am using, as you see, position across a square frame of glass tubing. This frame itself is suspended to a spring attachment which forms the top of the lamp, and reduces vibration effects considerably. The chief feature of the lamp, however, is its downward and uniform illumination. The light distribution is seen in comparison with that of a vertical filament lamp in the diagram shown on the screen (Fig. 6).

Through the courtesy of Professor Fleming, I am also able to show to-night some curves which have just been made of the peculiar variation in the field of illumination of flame arc lamps, and the effect of a reflector on the field. These measurements have been made at the Pender Laboratory with their large photometer by Mr. W. C. Clinton, the arc lamp being displaceable in horizontal and vertical directions to admit of

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exploring the illuminating power in different directions, according to the method of Dr. Kennelly. The very erratic distribution of the light is shown by the first three curves (Fig. 7), and though the extraordinary irregularity of the light intensity at different angles was at first thought to be perhaps due to errors of observation, further tests have fully confirmed the measurements. The evening-up of the illumination curve into a more or less symmetrical one, by means of a globe and reflector, is well shown by the last diagram (Fig. 8).

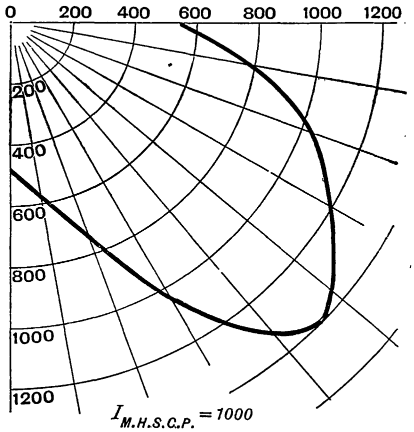

FIG. 8.

In conclusion, I trust that those present who are actively interested in illuminating engineering will forgive me if I appear to have trespassed too much on their province on the plea of spectroscopic methods, but modern education is causing many demands to be made with which the electrical profession were not faced even a year or two back, and, quite apart from the question of the ideal light for hygienic needs, there certainly is room for the introduction of "standard daylight" in the laboratories and testing-rooms of hundreds of industrial factories in this country, and for the greater utility of many of our public museums and galleries.

DISCUSSION.

MR. A. P. TROTTER, in opening the discussion, said the paper was full of most important and interesting observations, and would amply repay study by those who were engaged in some of the subjects with which it dealt. The author almost apologised for saying that the spectroscope must be used for such investigations as he had mentioned, but there was no need for such an apology, as it certainly must be used; because, for instance, the visual white light might be produced, as the author had shown, by three or four mono-chromatic bands in the spectrum, and when colour matching had to be dealt with a great deal better light than that was necessary. In that connection, however, the author suggested the very interesting point that if a combination of Maxwell's three fundamental colours was made, it was possible that that would be equivalent to a white light. That was a matter for experiment, not by one man only, but by various people, because the eyesight of people who might be described as having normally good colour vision differed very much. In colorimetry as practised in biological chemistry, where, for instance, the colour of blood was matched against carmine, one man might get a perfect match under certain circumstances, while other people would totally disagree with him. In colour matching, the whole of the spectrum had to be considered. The paper particularly interested him because he had been spending some time lately trying to get artificial daylight. He thought the time had come when, for certain purposes, especially in artists' studios, picture galleries, and many industries, good artificial daylight ought to be obtainable. Some twenty-three years ago he had described in a paper on the arc lamp the spectrum which was necessary for that; that was to say, he took Abney's spectrum of daylight and of the arc lamp and of the gas lamp, and showed what had to be done in order to produce artificial daylight. All artificial lights at present in existence were too rich in yellow and red, and those two colours had to be absorbed. As far as his experiments went he could not hope for such a small loss as 2 or 3 per cent., which the author mentioned. Dr. Mees had produced a filter which was photographically correct —a very different thing—and that gentleman only got 15 per cent. of his light through. But, for the purposes of artists and picture galleries, and many other purposes, it was not necessary to be photographically correct, and it was easy enough to get white light. He (Mr. Trotter) had at home a box full of daylight, apparently white light, and he had asked Messrs. Powells, the glass-makers, to supply him with different samples of blue glass. The first samples were of cobalt glass. As the author pointed out, it was not difficult to get a perfect match with daylight, but daylight was continually varying, and artists were apparently satisfied with the white daylight obtained on a grey day. A grey day was an ideal day for an artist, but Nature could not hold on in that respect for more than an hour or so, and the light varied from hour to hour. The cobalt glass was hardly any good, because although it was apparently a perfect white light, if it was examined through the spectroscope it would be found that it had four marked bands. He was trying other kinds of blue glass. One had to get a perfectly smooth spectrum, and that was a matter which could only be tried with a spectroscope and with spectro-

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photometry; and the information which the paper contained ought to be of the greatest use to those who were working in that subject. The author had thrown the tantalum spectrum on the screen, and had said that it was of interest at the present time because the tantalum lamps were being used. He (Mr. Trotter) did not quite see the connection, because that was the tantalum arc spectrum, and an ordinary tantalum lamp gave an incandescent spectrum. Was there any relation between the spectrum and the tantalum glow lamp—any selective emissivity having relation to its arc spectrum?

Mr. Leon Gaster thought that the Society ought to congratulate the author on his very interesting paper. He, however, desired to point out that Mr. Thorne Baker seemed to be acquainted with what had been done up to a certain period only. He had asked illuminating engineers to take notice of what had been done with regard to spectroscopic work and so on, but did not mention an interesting meeting of the Illuminating Engineering Society held in that very room about two months ago, when Mr. Ritchie had dealt with the subject of discrimination of colour by artificial light in a most up to date way. With regard to the manufacture of daylight, he could not agree with the author's optimistic figure of a loss of only 2 or 3 per cent.; this, as Mr. Trotter said, was quite at variance with the experience of Dr. Mees, who had actually shown a lamp of this kind on the night of Mr. Ritchie's paper. Moreover, no variety of "white light" which had gaps in its spectrum could reveal colours quite exactly as the author seemed to suggest.

Dr. F. W. Edridge-Green said the point at which illuminating engineers were trying to arrive at the present time was a very important one indeed, namely, how a light which was visually similar to daylight was to be obtained. There were two different methods which had to be taken into consideration. One appeared to give an effect which was a photo-chemical effect and corresponded more to the upper end of the spectrum; and the other appeared to give a visually stimulating effect which corresponded to the lower end of the spectrum. It was well known that the red light was the best for seeing at night, but it would be noticed that when the light was reduced the redness would disappear. The point to which he especially wished to allude with regard to matching daylight by artificial light was in connection with the three curves of Maxwell which had been thrown on to the screen. If any three points of the spectrum were taken, it would be found that they did not in any way correspond visually to white light; it was an absolutely different thing altogether. He would mention one or two simple examples which the members could try for themselves. One could undoubtedly make a more or less yellow colour by mixing, say, red and green, but if that yellow colour was shown to half a dozen people it would probably be found that they all differed and that perhaps only one would be satisfied that it was a match; one person would be clear it was green, and another person would be clear it was red. One way by which it could easily be seen that yellow was quite a simple sensation and not a compound sensation of red and green, was that yellow would not fatigue the eye for either red or green. Another very simple method by which it could be proved that yellow was a simple sensation was as follows. One could fatigue one's eye for green. For instance, one could put on blue-green spectacles which absolutely cut off the red, and then if one looked at the spectrum it would be found that one could pick out the yellow exactly at the same spot as one would do if the eye were not fatigued. If the whole of the series were in any shape or sense true, when the eye was fatigued for green, one would go right away up into the green—that was to say, the yellow junction would be shifted, but it could be picked out by means of shutters, such as existed in his spectrometer, exactly in the same wave-length. That showed the yellow was a simple and not a compound sensation. Therefore the point which he thought illuminating engineers should aim at was either to dull down the continuous spectrum or to form a spectrum which contained all the rays as nearly as possible to make an artificial daylight.

Mr. Thomas E. Ritchie remarked that the author had mentioned the importance of pure carbons, and he, the speaker, quite agreed with him in that statement. It was of supreme importance that the carbons used in an arc should be of the very greatest purity, but he immediately joined issue with the author as to the purity of the carbons used in obtaining the arc spectra which had been exhibited. From the appearance of the blue-violet end, he thought the author had failed to practise what he preached in that particular respect. He did not think that the spectra indicated anything like what could be got from pure carbons, which were obtainable without difficulty if they were required. He would like the author to give some information as to the percentage accuracy of the filter built by him, for which he claimed such a miraculously low absorption factor. No information had been given as to its percentage colour compared colour by colour right through the spectrum. He had been particularly interested in the author's remarks as to the variation of the spectrum of the neon tube, with the alteration in the periodicity. It perfectly agreed with that of the ordinary open arc, which also varied in much the same way. He should also like to inquire if the author's filter had been in existence for a sufficient length of time to enable Mr. Baker to furnish any information as to its permanency. That was a very important point in Dr. Mees's experiments—the investigation had been very thorough, and it was known with reasonable certainty that the filter, as it was now being made, was permanent, which, after all, was the great

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thing. The efficiency was not of so much moment as compared with the permanency. He should also like to ask the author whether, with the concave grating he had used, he had been able to obtain in the Sanger-Shepherd camera anything in the nature of spectrographs taken by reflected daylight, and reflected artificial light.

Mr. J. S. Dow said he strongly felt that, in testing the effect of illuminants on colours, it was not enough, however skilful one might be, to make photographic tests alone, and one of the features of Mr. Ritchie's researches was that he not only did the photographic tests, but he also made an analysis of the colours of a series of ribbons by the tintometer apparatus, and tabulated photometric and visual effects in conjunction with those data. One point which the author might have mentioned was the important effect of colour on the efficiency of the illuminant. It was estimated that if white light only was produced in the spectrum 26 candle-power per watt would be produced, whereas, if a green-yellow ray only was selected, as much as 50 candle-power per watt would be obtained. The most efficient lamp at present available probably did not give more than about 5 candle-power per watt. Mr. Ives had been led recently to suggest a standard of light based on the green mercury line only, but he (the speaker) thought that standard, and also the helium standard experimented with at the Bureau of Standards, was open to the objection that the physiological difficulties of comparing lights so very different from a true white light were very serious, probably so serious as to do away with the advantage of any improvement in the physical control of the lamp. And Dr. Edridge-Green had proved the complexity of the retina when one came to compare such illuminations; the Bureau of Standards had not decided to adopt the Helium standard, which was only in the experimental state as yet. With regard to the mixture of red and green lights to make an apparent white light, there was no question, he thought, that a white light made in that way would give quite different results from a genuine white light when one came to compare different colours. He (the speaker) remembered a very interesting series of researches in which a microscopic investigation was made of the wing of a butterfly, and the experimenters came to the conclusion that the colour of those particles was due to the fact that their diameter was in the neighbourhood of the respective wave-length of light; and that the colours of objects in general were due to the fact that they were of a size to resonate with certain wave-lengths of light reaching them. Perhaps the author would express his opinion on the validity of that theory.

Mr. E. P. Hollis said he noticed that when the author wanted to make a filter for his daylight, he added various colours. He would like to know whether he had made any experiments with regard to mixing gases in the tube.

The Chairman, in proposing a hearty vote of thanks to Mr. Thorne Baker, said there was one point on which he would have liked some information, and which he was sorry to see the author had not dealt with, namely, as to what coloured glasses one ought to use to protect one's eyes. In old days, people used blue glasses, but at the present time a kind of yellow glass was in vogue. One would expect that the eye would naturally be accustomed to sunlight. For sunlight smoked glasses were used to soften the strength of the rays, but for artificial light something was required by which the excessive yellow would be moderated. He would like some information from the author on that point. With regard to the practical application of such things as spectroscopes, he thought the spectroscope was being used in a more general way than scientific people realised. Quite recently an electric light company was asked to illuminate Billingsgate Fish Market. They said there was no difficulty whatever, and put in a lot of arc lights. The heads of Billingsgate Fish Market promptly interviewed the company—using, he presumed, the language of that district—and explained that the light would not do at all, because it made the fish look unfit for human consumption. Thereupon the company spent over £100 in fitting up a laboratory with a spectroscope, and other appliances, and began working until they obtained such a light that it not only made the fish look edible, but quite attractive. They were then asked to illuminate another part of Billingsgate, which they did. The Billingsgate magnates, however, then complained that the haddocks and herrings were made unsaleable by the light, so the company had to set to work again in order to get a light which would suit the haddocks and herrings, a difficulty they succeeded in overcoming, so that at the present time Billingsgate was successfully illuminated by the City of London Electric Light Company. Having succeeded in the fish market, they illuminated the game market, where the same difficulty arose, but again it was overcome. It was always a great pleasure to anybody to listen to, or to read a paper by Mr. Thorne Baker, who was one of those people who worked away quietly at their subject, and who, when they gave a paper, crowded a tremendous lot of information into it in a very unassuming kind of way.

The vote of thanks was carried by acclamation.

Mr. T. Thorne Baker, in replying to the Chairman's question regarding the colour of glasses used for spectacles, said he had no doubt, from his experiments with bacteria which had been going on in his laboratory for the past four years, that green was the favourite colour for every kind of organic and vegetable life. The conditions of growth, reproduction and everything else were normal, and he therefore thought that the green rays were

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most suitable for human beings as well. A fact which bore that out was the extraordinary lack of fatigue experienced by people who were working in mercury vapour light. In reply to Mr. Trotter, and also to those who did or did not hold with Clerk-Maxwell's theory, the Clerk-Maxwell curves varied for each person. If any Clerk-Maxwell tests were made on a person who was colour-blind it would very soon be discovered in which one of his visual curves he was deficient. But he (the author) did not think the fact of different people varying in their power to appreciate the three curves, assuming those curves to be correct, should affect any theory regarding what an apparently white light produced by three or five lines in the spectrum, could or could not do. It might just as well be said that, because some men were tall and others were short, nobody should wear boots. He had to make an apology with regard to his figure of 3 per cent. loss, which appeared to have caused a good deal of criticism. Naturally the loss which was going to be obtained by screening light varied enormously with the different type of illuminants. When correcting the proof of the paper he quite at haphazard mentioned the figure of 2 or 3 per cent., but he had in mind the arc lamp. With an arc lamp, one would simply filter out rays like the ultra-violet, which, not being visual, had no visual value; but he quite recognised that where tantalum and tungsten lamps were being dealt with, the efficiency would be much less. With regard to the tantalum spectrum he had thrown on the screen, and to which Mr. Trotter referred, he had no intention of showing it as being interesting from the electric light point of view in connection with tantalum lamps or metal filament lamps, but he was thinking more especially of research work which was going on, particularly on the Continent, at the present time, in preparing cores for arc lamp carbons. While mentioning that subject, he desired to refer to the remark of Mr. Ritchie who said he did not think he (the author) had used pure carbons. Only one of the carbon spectrograms he had shown was supposed to be with pure carbons. A very careful analysis failed to find any impurity. He had copied with the greatest accuracy he possibly could the work of somebody who was very much more qualified to speak than he himself was in order to get pure carbons, and he believed they were pure. Of course it could be argued against that, anyone would get in the arc, nitrogen lines and carbon dioxide lines, which were not present in the carbon itself. He did not mean to suggest that pure carbon should be used for arc lights, but that the impurities should be pure—that was to say that quite pure carbons ought, if possible, to be taken, and cored with standardised chemical matter. With reference to the visual and spectrophotometer test, he did not suggest the photographic tests were going to do away with the visual tests he thought it most essential they should be carried out together. Finally, he was not putting forward the suggestion of combining vapour tubes to give a white light. The whole point of the paper was to screen light in as efficient a way as possible in order to get daylight. The vapour lamps o any kind would be a compromise, although it might prove from a hygienic point of view they were a perfect compromise. There was one other point in connection with the efficiency of his filter. Later on, he would endeavour, with the permission of the editor, to publish a note about the measurements. He thought it was quite possible that he became possessed of one or two dyes, which might make the subject very much easier than would appear at first sight. The yellow screens used in photographic work for filtering out the ultra-violet rays for orthochromatic photography, until a year or two ago, used to increase the exposure by something like five or seven times. Exactly the same effect could be obtained now by only increasing the exposure about one time—that was to say, doubling it—owing to the introduction of some very transparent but efficient dyes brought out by Dr. Koenig, and through the courtesy of one of the biggest dye companies in Germany he (the author) had practically all the new dyes which were likely to be of interest to him sent over for him to test; and he thought that he must have in the case mentioned obtained possession of one or two dyes that had an increased efficiency similar to the yellow dyes, which might account for an increased efficiency in a filter. As the dyes might be of considerable value, he would be pleased to publish the names of them in the *Journal* when an opportunity occurred.

THE SVASTIKA.

By one of the happiest of many similar happy accidents, I am able to file for record in our *Journal* the names of two more countries where the *svastika* has been in unbroken ritualistic usage from beyond the uttermost memories of their inhabitants; and to provide photographic illustrations of this profoundly interesting religious symbol as fashioned in, or for, each of these countries. I say, "or for," because all three of the *svastikas* photographed are of some identical alloy of silver, and are worked identically on both sides [thus indicating some community, if not actual centre of production, as in Russia], so that if hung with the transoms turned to the right, they show the cross of invitation and blessing, and if to the left of repulsion and implacable cursing; which latter form of the *svastika* European *pandits* have named *suvastika*, a nominal differentiation I never myself heard of in Bombay. No. 1, stamped on a triangular plate, is from Siberia, where it is worn only by the Buddhistic Mongolians, and is held in abhorrence by the Christians, and in its setting it recalls the left-handed *svastika* [*suvastika*] stamped on the pelvis of the Babylonian leaden figure of a woman, said to represent the goddess Nana [Anna, Ishtar, &c.], found by Schlieman in the ruins of Troy. Nos. 2 and 3, both

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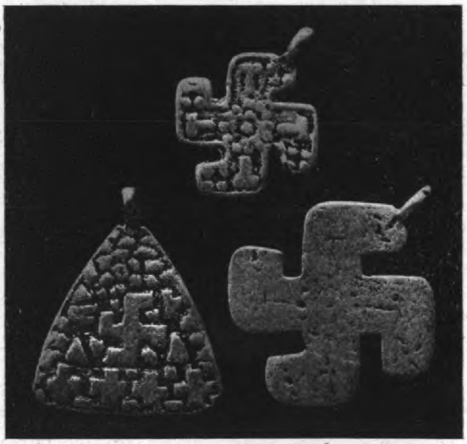
free *svastikas*, are from the Caucasus, where they are worn by all the inhabitants. The open-work one [No. 2] bears a rose-like, or a lily-like, form in its centre, and in each of its four limbs, representing the Earth, and the Sun revolving round it through the Heavens, from East to South, and on through West to North; while the more solid one bears obscure indications of the same figuring;—both of these *svastikas* recalling the Rosy-Cross of the illusive Rosicrucians; and likewise the crucified Gorgon Head of Medusa. I came upon all three *svastikas* at 41, Old Bond Street, opened there some three or four years ago, for the sale of "Russian Peasant Industries"; and conducted by good Russians, who gave me this information of the provenance and indigenous use of these *svastikas*.

The word *svastika* is Sanskrit. *Svaist*, literally "It is Well," is the name of the right-handed [*dakshina-patha*] *svastika* placed in India by the

2.



1. 3.

1. From Siberia. 2 and 3. From the Caucasus.

Hindus, at the head of all letters, bills [cf. our "Laus Deo"] and other documents, and at all beginnings, especially entrances, as a benediction; and *svastha*, "the condition of blessedness";—in Bombay the recipient of any Government salary, or pension, however exiguous, being delightfully and most soothingly designated *svasthya*, "the Blessed One"; and I always heard from my Brahman instructors that the word *svastika* meant, at full length, "the *tika*" [cf., "ticket," and ευστικτός, "well painted"] or "sign of Benediction," or "Blessedness." European *pandits*, however, say that *svastika* means simply "Be Blest." The Lower Greek equivalent of the word is "Gammadion," *i.e.*, "the (4) Greek G's (Γ),"—the "L catch L" of the ingenious argot of our English Schools of Design; the other equivalent of it, although not running "on all fours" with it, being the terrible "Triskelion," or "Three Legs" of Sicily, and the "Triquetra" [literally "three-cornered," as opposed to "quadrata"] or "Three [Legs of Man]," brought from Sicily, but without the inset Medusa Head, into the Isle of Man by the Crusaders; and known among ourselves as the fylfot, popularly corrupted to "fly-foot"; the term etymologically meaning—"Fill the bottom," *i.e.*, of the design with this three-limbed [or it might be four-limbed] symbol;—as a direction by a craftsmaster to his craftmates.

It has been made clear during the past thirty years that at one time or other the symbol of the *svastika* was in immemorial use throughout every country of the world; while now, with the three *svastikas* here photographed, it is demonstrable that its use has been maintained in uninterrupted sequence through countless generations down to the present day, not only in India and Farther India, but over all Higher Asia, and Northern Europe, and North America, and along the Rocky Mountains and the Andes, southward, into Peru; and across the Mediterranean, in Africa; and, in India at least, in all its aboriginal hierographic and hieroglyptic significances. It was first deliberately brought to general notice in this country by Major Edward Moor, Commissariat-General at Bombay, in his "Hindu Pantheon," 1810; and in both its rectangular Indian forms, right-handed and left-handed, as the sectarial *tikas* or "marks" on the forehead, respectively of the Bombay Jainas or Hindu Buddhists, and the *sakti* [*i.e.*, worshippers of the female power of the Creator] Hindus; and subsequently, altogether casually, by Owen Jones, in his great "Grammar of Ornament," 1856; and I reproduced Moor's plate in "The Industrial Arts of India," for the Science and Art Department, 1880. But it was Schlieman, by the illustration of the leaden cast of the Babylonian goddess Nana in his "Troy," 1883, who first really attracted the attention of this country, and of all Europe, and the Americas, to the symbol. Afterwards notices of its occurrence came in from all the four quarters of the globe it images; and Greg published his "On the Meaning and Origin of the Fylfot and Swastika," in 1884; and Count Goblet D'Alviella, his "epoch-making" [as Grant Allen rightly termed the volume] "Migration des Symboles," in 1891; which was immediately reproduced in English under my editing [with an Introduction, and added plates] by Messrs. Constable and Co.; and Max Müller wrote much about it, in the *Athenæum*, and elsewhere; while from the first I procured the use of it on bookbindings and in jewelry; until, at last, it has become one of the commonest articles of "lucky" trinketry sold by the cheap jewelers of London: but too often, most unfortunately fashioned in the form and coloured after the chromatism of the left-handed, or "unlucky" *svastika*—the so discriminated *suvastika*.

Of course, what chiefly concerned the learned of Christendom was the meaning and origin of this ubiquitous *svastika*. India proferred the answer to both questions with "a largess universal like the Sun" it symbolises. Edward Thomas, the

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most scholarly, keen, and eminent of Oriental numismatists, had shown so early as 1880, in the *Numismatic Chronicle*, that the *chakra* ["Wheel"], or symbol of the sun, had been gradually replaced in ancient India [probably under the influence of the Buddhists] by the rectangular *svastika* [till then only a symbol of Fire, and of the Fire God Agni], its clockwise rotation being indicated by the directions of its four "feet" or transoms. But it was all in vain: for the *savants* of the West were still dominated by the unmeasured denunciation by Bentley of the license of the literary Hindus in the most presumptuous impostures, and the emphasis given to his reprobation of them by the flagrant forgeries foisted on Colonel Wilford, of the Honourable East India Company's Bengal Army, one of the most industrious and inspiring of the European pioneers of the revival of Sanskrit learning in India; and so no serious heed was given to the researches of Edward Thomas until Professor Percy Gardner made, in, or about, 1892, his ever-memorable discovery of a Greek coin of Megarean Mesembria [the City of "the Mid-day" sun] in Thrace, with the name of the town rendered on it by a *svastika* [represented *counter* clockwise!] prefixed by the syllable MES. That closed the controversy.

All the same, the Indian evidence, in its obvious authenticity and ever-rising volume, of the *svastika* being a solar symbol, was from the first overwhelming for any student who had studied the question in India, and at the feet of some Brahmanical Gamaliel. It is not only that it appears as a tangible object everywhere — on temples, and sculptures, and houses; on coins; on documents of any formality and importance; on various utensils, and on carpets, and hangings and textile fabrics of all denominations; and in jewelry of every kind; in short, universally, and always with its benedictory meaning clearly articulate; but its name is applied also to the act of the *pradakshana* [proceeding by the right hand] or circumambulation of the sacred *tulsi* plant [*Ocymum sanctum*], and of any shrine; and to the sun's procession through the Heavens, and of the movement of the shadows cast on the Earth by the buildings, trees, etc., the sun, on its southward and westward course, may shine upon:— and it is remarkable that it is this course of the Hindu *svastika*, from East to South, and on from West to North, and not the course of the Christian Cross, from North to South, and then from East to West, that the Archbishops of Canterbury follow when they proclaim the Kings and Queens of England at their coronations in Westminster Abbey, to their assembled people. The term *svastika* is also applied to the eternal *pradakshana*, or revolution of the whole stellar Cosmos about its unknown and unknowable postulated centre, to which the name of "Hercules," has been so bathetically given. Again Hindu temples are but shrines, providing no space for congregational worship; being, in my opinion, simply architectonic reproductions of the covered bullock-cart in which the Hindu gods were carried about by the Aryas, from one camping-ground to another, across the Indus and along the course of the Ganges during their earliest immigrations from Central Asia into Hindustan, and consist simply of (1) a cubical shrine [*vimana*], representting the body of the cart, and containing the idol, (2) a pinacle [*sikhara*] of a sightly curved profile, [like that of the spire of the parish church of Ambleside], terminating in a finial [*amlika*, or *aonla—i.e.*, shaped like the fruit of "*Phyllanthus Emblica*"], and representing the canopy of the cart, and (3) a porch [*mantapa*] representing the awning over the bullock-driver's seat in front of the cart. This is the type of the Hindu temple all through Maharashtra, or the Mahratta Deccan ["Right-hand-going-sun-land"], and in all these temples the pavement round-about, or, rather, square-about, the shrine, or *vimana*, is called the *svastika*. The very way, "by the right," in which our clock-handles turn, transparently refers back at last to the attribution of an ardently-breathed blessing, by the archaic Aryan worshippers of the rising sun, to everything that was reflective of, or remindful of, its right-hand course through the high Heavens; and our words, "righteousness," and "dexterity," and "sinister" all take us directly back to this sun-worship of our barbarian forefathers, as they appear emergent out of savagery; and to this day, although our "handed" clocks were not invented before the eighth century, A.D., nothing is regarded among us as more "unlucky" than to move the hands of a clock backwards, that is "by the left." Moreover, "*svastika*" is a Hindu synonym of the paired "Fishes" of the Zodiac; and not because they are often represented crossed, but because all through the past 2,000 years the Sun at the Vernal Equinox has risen in the sign of Pisces, as for 2,000 years before that he rose in Aries, and again 2,000 years before that in Taurus; and presently the Sun at the Vernal Equinox will come under the sign of Aquarius, otherwise of the "Vase of Ichor," marking in the theologised astronomy of the Hindus, which is both Babylonian and Greek, the opening "as with a noise of thunder" of "the seal" of a new "Dispensation" of all things mundane and celestial; but whether of greater felicity than those which have passed away or of greater woes—"filling the wide Vessel of the Universe" with blood—"the magicians and the astrologers, and the sorcerers, and the Chaldæans" [Cicero, Div. ii. 47] of India are too subtle-witted to "entertain conjecture," before they know!

And the *svastika* survives in India to this day as a symbol of Fire and of Agni, as well as of the Sun [Surya], lighting up for us "the dark backward and abysm" of the time when the Hindu Aryas were as yet primæval savages, and fire was for them the highest connotation of Divinity; and was artificially produced by plugging two crossed bars

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of wood into [a square box [*pramatha*], the box [tinder-box!] wherein Prometheus concealed the Fire he "stole from Heaven," and violently rubbing them round and round with a stump of well-dried wood, until ignited by the calorific force, the "Promethean heat," thus generated. I have a ladle of "blackwood" [*Dalbergia* sp.] once used for pouring oil on the sacrificial fires of the last temple of Agni remaining in the Presidency of Bombay. It is about two feet two inches in length, and almost as heavy as iron; and fashioned like a sceptre. Just 1½ inches below the pear-shaped bowl [6 by 3¾ inches], carved so as to resemble the *yoni-linga* symbol, there is, in violent interruption of the artistic configuration of the ladle, a cubical block [about 3½ by 3½ by 1½ inches] having its upper surface deeply carved out with a bold representation of the rectangular, four-plugged, *svastika*, and its lower surface with a shallow and weak representation of a tortoise; the Tortoise that supports the Elephant, that bears up the world in space; and 5½ inches from the end of the ladle its handle expands into a circular mass, 2½ inches in diameter, and 1½ inch in depth, bearing on its upper surface the conventional eight-petalled representation of the Indian Sacred Water Lily [*Nelumbium speciosum*], the "Rose" of the Rosicrucians. I believe this ladle to be an absolutely unique relic of the rapidly obsolescing temple [not domestic] worship of Agni in Western India; and that the "cuboid mass" interpolated in its handle is an almost literal reproduction of the Promethean Fire-box.

Finally, for the guidance of jewelers: the right-handed *svastika*, the symbol of the sun, and of light, and the highest heavenly glories and majesties, and of man, and health and happiness, and all blessing, and blessedness, spiritual and material, temporal and eternal—alone is "lucky"; and can be fashioned only of gold, and coloured, if enameled on any other metal, only red the colour of the East, or yellow the colour of the South. The left-handed *svastika*, or *suvastika*, is the symbol of the moon, and of moonlight [Virgil, Æn. vi. 270], and all darkness, and supernatural terrors, and of woman, and all mortal diseases and disgraces, and every infernal imprecation and degree of damnation—and can be fashioned only of silver, and coloured, if enameled on any other metal, only blue or green, or yellow or white, blue or green being the colour of the West, and white or black of the North; and its proper *precious* metal, and any of its proper colours, are deadly unlucky, even if used in the fashioning of a right-handed *svastika*:—the *suvastika* being, indeed, the most potent of maledictory symbols, more ruthless and relentless in its ghastly tentacular grip than the crushing coils of the Anaconda, and more lethiferous in the malignancies emanating from it than the envenomed exhalations of the fabled Upas tree. If worn suspended, both *svastikas* should be hung from one of their corners, and not from any side of them. In the plate added by me to D'Alviella's "Migration of Symbols" is a *svastika* as rendered in Arabic of one of "the 99 names of God, from a mosque in India, where it is the equivalent of the upheld hand of God to be seen on some Saracenic buildings in Spain" [Exod. xviii. 11]. The Hindu coloration of the four quarters of the Earth and the Heavens—Red, Yellow, Blue, and White—is correctly represented on the distinguishing flag of the Peninsular and Oriental Steam Navigation Company.

GEORGE BIRDWOOD.

SNAIL-FARMING AND CONSUMPTION OF SNAILS IN FRANCE.

The demand for snails, as an article of food, in France is said to have greatly increased of late years. It is estimated that Paris alone consumes upwards of 100 millions of this mollusc annually, of which no fewer than 84 millions are sold at the Halles Centrales. The two species of edible snail sold in the market are the "Escargot de Bourgogne," the *Helix pomatia* of the naturalist, commonly known as "le gros blanc," and a smaller kind (*Helix aperta*), "le petit gris," with a shell of dark mottled-grey colour. The former, which is the most appreciated, and commands the highest prices, is found principally in the wine-growing districts of the east and south-east of France, whilst the other is common in fields and gardens in the west and other parts of the country. The vineyards of Burgundy and Champagne being no longer able to meet the present demand, the chief supplies for the Paris market are now obtained from the departments of Bouches-du-Rhône, Daubs, Somme, Sarthe, Vendée, Calvados, Seine-Inférieure, and the Côte d'Or. Snails are also imported from Italy, Switzerland, and even Germany. Lately, important consignments of snails have been sent from Algeria to the Halles.

The habits of the snail are too well known to need description here. It is hermaphrodite, and lays from fifty to sixty eggs in the early spring, and occasionally again in July. The eggs hatch twenty-five to forty days later. At the first sign of cold in the autumn, the snail hides in holes, closing at the same time the entrance to its shell with a fluid secretion, which, when dry, forms a film of a calcareous substance. In this state, termed *bouchée*, it hibernates, and remains in a torpid state until the spring.

The snails are chiefly collected by children, who hunt for them in fields, vineyards and gardens. They are sold to the dealers at the rate of a few pence per 1,000. They are placed in "escargotières," or preserves, where they are kept and fed until required for market. These preserves must be surrounded with a wall or fence to prevent the escape of the stock, for the snail is a great wanderer, and in wet weather is difficult to keep within bounds.

An escargotière should contain a number of shelters, small buildings about 6 feet by 3 feet, with a roof of tiles or boards about 18 inches from

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the ground. They should be placed about 3 feet apart. The snails, about 2,000 to each shelter, are placed on a layer of dry moss. The escargotières require to be well shaded and situated on a well-drained calcareous soil.

The snail is a voracious eater of salads, cabbages, etc., in fact, nothing in the way of green food comes amiss, and it is essential that it should have an abundant supply. Being a nocturnal feeder, fresh food must be distributed round the shelters at sunset, and the débris cleared away every morning soon after sunrise. Cleanliness is the great secret of success in snail-farming, and, if this be not attended to, great mortality is sure to ensue. Crows, jays, and other birds, as well as hedgehogs and toads, are amongst the principal enemies of the snail, and must be kept away from the enclosures.

The breeding and rearing of snails for market is a far more important undertaking than that just described; it requires more care, foresight and attention. The selection of a site for such a farm is, of course, of primary importance. The soil, if not naturally of a calcareous nature, must receive a dressing of chalk, lime, or marl. It should be, if possible, well wooded, well drained, and covered with turf. The size of an enclosure will vary according to the number of snails it is intended to rear. This should not exceed 100 per square metre, or one million per hectare (about 836 per square yard), or 400,000 snails per acre.

Means for sprinkling the enclosure with water during the hot and dry weather must be provided.

Shelter in the shape of little grottoes of rockwork must be built. The ground requires to be well dug over in the early spring and covered with dry leaves, moss and even straw. The brood-snails are placed on this bedding about the middle of March. On an average, 1,000 of these will produce about 50,000, which will be hatched towards the end of April.

Snails must be abundantly fed in order to grow quickly, and if this be attended to, the "petit gris" should be ready for market by the end of the year. The larger kind, "le gros blanc," requires at least eighteen months to arrive at maturity.

The profits of a snail farm must depend largely on the cost of food, which for a large establishment is considerable. It is therefore advisable that it should be situated in the neighbourhood of market gardens, where a plentiful supply of green food can be obtained cheaply.

In the autumn, at the first sign of cold, heaps of dry leaves must be placed in the enclosure for the snails to hide in when they close their shells. They are then stored on trays in cellars or out-houses kept at a temperature of 3° C. to 6° C. (37° F. to 42° F.).

At the market, snails are denominated *courreurs* and *bouchées*. The former, as the name implies, are those in full activity, and are sold from April 15th to May 15th. They are sent to market in boxes pierced with holes, containing 500 to 2,000 each, and weighing about 25 kilogs (½ cwt.) each. As these deteriorate rapidly a quick sale is required for them. The wholesale prices of the "petit gris" vary from 1·50 francs to 2·50 francs (1*s.* 3*d.* to 2*s.* 1*d.*) per 1,000, whilst the "gros blanc" fetches from 5 francs to 12 francs (4*s.* to 10*s.*) per 1,000.

The closed snails (*bouchées*), which are sold from the middle of October until April, obtain the best prices. They keep much better. The prices for the "petit gris" range between 4 francs and 5 francs per 1,000, whilst the "gros blancs" fetch 12 francs to 25 francs per 1,000.

According to information supplied to the writer by the administration of the "Halles et Marchés" of Paris, the average price obtained for the "gros blancs" *bouchées* has been 20 francs (16*s.*) per 1,000, whilst the *courreurs* realised on the average 12 francs (9*s.* 7*d.*) per 1,000.

OBITUARY.

John Kershaw.—Mr. John Kershaw, C.E., whose death recently occurred in London, at the age of eighty-five, was a member of the Royal Society of Arts since 1882. Mr. Kershaw was articled to the late Mr. John Viret Gooch, brother of Sir Daniel Gooch, and was associated with the South-Western Railway, being afterwards (about 1860) appointed locomotive engineer of the Great Indian Peninsular Railway at Bombay. While there, he showed great skill in devising and carrying out the extensive works and mechanical arrangements of the Byculla and other depots, especially the rapidity with which he effected the haulage of the rolling-stock for the Deccan line up the famous Bhore Ghaut incline, a task for which he received the thanks of the Indian Government. After leaving India (through ill-health) Mr. Kershaw was connected with the firm of Sharp, Stewart at Manchester, and also with the railway carriage works at Oldbury, near Birmingham. His professional services included some experiments dealing with the consumption of fuel of trains, and several improvements for engine construction.

NOTES ON BOOKS.

Rating Locomotives. By H. L. Cole. London: W. Thacker & Co.; Calcutta and Simla: W. Thacker & Co. 10*s.* 6*d.* net.

The aim of this little volume is to present to railway officers as concisely as possible, and in the handy form of a pocket-book, an account of the general principles governing engine-loads and train-speeds, and the present state of knowledge regarding the actual power developed by steam locomotives and the resistance to traction of various types of rolling-stock under ordinary working conditions. The important question of brake-power also is considered. Convenient diagrammatic methods are described for dealing with various

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problems connected with engine-rating and the computation of train-loads, and the free use of charts, in most cases self-explanatory, has made it possible to compress a somewhat large subject into a relatively small compass.

The author has aimed at representing only essential principles and data for everyday working. The formulæ quoted, and in some cases originated by the writer, have in all cases been tested under working conditions, in the majority of cases within the writer's own personal experience.

Written and published in India by a district locomotive superintendent of the Indian State railways, and intended primarily for the use of railway officers in India, some of the formulæ given in this book naturally refer in particular to Indian conditions. These, however, are specified; and throughout the book advantage has been taken of the most recent experiments bearing on the special subjects dealt with. In all cases the simple graphical methods suggested are such as have been found serviceable in actual practice, and their possible applications are limited by neither gauge nor country.

BUILDING CONSTRUCTION AND ARCHITECTURAL DRAWING. By John A. Reid. London: Blackie & Son, Ltd. 4*s.* net.

This work, which is designed for young students of building construction, consists of a series of eighteen large plates, illustrating brickwork, masonry, mouldings, and the various parts of a building, and a pamphlet of thirty-two pages containing some explanation of the drawings. It is intended that the illustrations should be used not for mere copying purposes, but as exercises in drawing to scale. Mr. Reid is an old pupil of the Glasgow School of Art, which has contributed so much to improve the cause of art in this country; he has also done good work as a teacher of building construction under the Glasgow School Board, and he is therefore well qualified, both by training and experience, to produce a thoroughly sound and practical work on this subject.

KAEMMERER'S PRACTICAL LETTER BOOK. Edited by Arthur Seymour Jennings. London: The Trade Papers Publishing Co., Ltd. 30*s.*

DISTINCTIVE LETTERING AND DESIGNS. By A. J. Hewett. London: The Trade Papers Publishing Co., Ltd. 1*s.*

Kaemmerer's handsome volume contains one hundred and forty large plates, illustrating several hundred alphabets. The thoroughness of the work is shown by the fact that among the illustrated alphabets are Greek, Hebrew, Anglo-Saxon, Irish, Old Gothic, Malayan and Assyrian. The book has been designed for the use of sign-painters, show-card writers, decorators, artists and craftsmen. A great many of the plates, especially the earlier ones, are, therefore, extremely plain, and hardly lend themselves to artistic treatment; but the letters are admirably clear, and serve as excellent models for the humble necessary sign-painter. It would, perhaps, have been an improvement if the names of the various styles had been printed on the plates. The book contains neither index nor list of contents, and it is therefore sometimes difficult to find what one wants, or to know, when it is found, whether it is what one wanted.

Mr. Hewett's little pamphlet contains a couple of good alphabets, which should be useful to sign-writers, etc., but a good many of his suggestions are commonplace and ugly. The short article on lettering, in which he pleads for plainness and legibility, is full of excellent common sense.

GENERAL NOTES.

THE GROWTH OF CANADIAN CITIES.—Regina, the capital of the Province of Saskatchewan, is a characteristic instance of the rapid growth of new towns throughout western Canada. Nine years ago the place had no importance, and a population of only a few hundreds. It has now developed into a busy centre, with 30,000 inhabitants. With the inflow of settlers the advantages of Regina as a strategic point for traffic was recognised by the three great transcontinental railways, who have now made it a divisional point for their respective systems. The extent of new building in 1911 amounted in value to a million sterling, and the building programme for the present year, it is stated, will exceed that amount. The municipality has also spent a quarter of a million sterling on street and other improvements. An electric street railway of seven miles has just been completed, and is municipally owned; and waterworks which will ensure a supply of water to a population of at least a hundred thousand are in hand, the machinery and piping for which are being imported from England. The wholesale houses of eastern Canada and the manufacturers of machinery are making Regina their chief distributing point for Saskatchewan, and the turnover in agricultural machinery, which reached nearly a million sterling in 1911, has never yet been equalled at any single point.

THE HOME MUSIC STUDY UNION.—This society does for music very much what is done for literature by the National Home Reading Union, to which it is affiliated. There are now about forty centres connected with it, and some nine hundred members working under its direction. For several years the executive committee has been arranging courses of study suited to various classes of musicians, and in the official organ, *The Music Student*, special articles appear dealing with these courses. The union also issues text-books on musical history and theory, and thus provides many students of music with assistance which otherwise they could not easily obtain. Conditions of membership and all further particulars may be obtained of the Secretary of the Union, 12, York Buildings, Adelphi, W.C.

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International Congress of Industrial Hygiene.—An International Congress (Congrès Technique International Prévention des Accidents du Travail et d'Hygiène Industrielle) will be held at Milan from May 27th-31st, 1912, under the patronage of H.M. the King of Italy. The objects of the Congress are: (1) to make known the best means adopted in various countries to secure safety and health in workshops; and (2) to encourage the study of those practical problems of this nature which have not yet been satisfactorily solved. Further particulars may be obtained from the General Secretary, Ing. F. Massarelli, Foro Bonaparte, 61, Milan.

Coffee-growing in Madagascar. — Coffee-growing in Madagascar is beginning to take an important place amongst the agricultural industries of the island. In the Mananjary district there are no fewer than twenty coffee-growing estates, containing at least 700,000 plants, producing at the present time about 120 tons annually. It is estimated that the yield from these plantations will in a few years' time be increased to at least 500 tons. The Liberian variety of coffee is chiefly grown in Madagascar, but many planters are introducing a quality resembling East Indian, with small berries and thin husks. Madagascar coffee is beginning to find a market in France.

Electric Light for Sterilising Milk.—Attention has recently been called in Holland to the effect of ultra-violet beams on bacteria, and to the fact that such beams are abundantly developed by mercury incandescent lamps; moreover, according to the American Consul at Amsterdam, it has been stated that through this medium milk may now be sterilised in a few minutes. An apparatus has been constructed, it is explained, whereby the milk flows in a thin stream along an electric light. Demonstrations were first made with water infected with different kinds of bacteria, and it is said that the water was purified in a few minutes without appreciably increasing its temperature. The result is attributed to the quality of the ozone formed under the influence of the light, but the demonstrations must be conducted where there is sufficient room for the light to burn freely.

The Production of Nux Vomica in Ceylon.—The tree producing strychnos nux vomica grows in abundance in the jungle districts between Kurunegalla and Jaffna, of northern Ceylon. The tree is not cultivated, and the seed is gathered by natives on their own account and sold to Moorish traders, who in turn sell to the Colombo exporters. The production is not controlled. The districts in which the nux vomica seed is found are full of malaria, and for this reason the natives refrain from entering the jungle to collect the seed. It is stated that monkeys are fond of the fruit, which is to them harmless, but are careful to drop the seed, and this can be picked up with ease from the ground. However, little seed comes to the markets, and the real reason for this is most probably that in Ceylon there are so many other occupations more attractive and remunerative than the gathering of this cheap seed in the jungle. During the nine months ended March, 1911, 547 cwt. of nux vomica seed were exported from Ceylon, the value of which was about £220.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

March 13.—Professor Ernest A. Gardner, M.A., "Greek Sculpture." Lord Sanderson, G.C.B., K.C.M.G., will preside.

March 20.—F. Martin Duncan, "The Work of the Marine Biological Association." P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., will preside.

March 27.—Theodore E. Salvesen, "The Whaling Industry of To-day."

April 17. — John Henry Coste, F.I.C., "Municipal Chemistry."

April 24.—George Fletcher, "Technical Education in Ireland."

May 1. — William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

May 8.—E. D. Morel, "British Rule in Nigeria."

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

March 14.—E. A. Gait, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

April 25.—Sir John O. Miller, K.C.S.I., "The Central Provinces."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

March 26.—Leonard Lovegrove, "British North Borneo."

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

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CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

LUTHER HOOPER, "The Loom and Spindle: Past, Present, and Future." Three Lectures.

Syllabus.

LECTURE III.—MARCH 11.—*The Modern Loom for Plain and Ornamental Weaving and its Future Development.*—Eighteenth century inventions compared with those of earlier periods—The drawboy—The drawboy machine—The Jacquard machine or *draw-engine*—Kay's *fly shuttle*, its great utility and unexpected value—The first power-looms—Application of steam power to the loom—General adoption of the factory system in textile industries—Comparison of hand and power-looms as regards quality and speed of weaving—The effect of machine weaving on the workers—Defects of the power-loom—Electricity as applied to the loom—The loom of the future.

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

March 18, 25, April 1.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 11...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Luther Hooper, "The Loom and Spindle: Past, Present and Future." (Lecture III.)

Mechanical Engineers, Storey's-gate, S.W., 8 p.m. (Graduates' Section.) Mr. R. D. McGroarty, "Water Softening and Purification."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Dr. W. E. Montgomery, "Some Aspects of the Licensing Question."

Sanitary Engineers, Institute of, at the Royal United Service Institution, Whitehall, S.W., 8 p.m. Mr. P. M. Fraser, "The Modern Home."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. Edwin Savill's paper, "The Single Tax Movement."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. J. M. Bell, "The Volcanoes of New Zealand."

Post Office Electrical Engineers, Institute of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 5 p.m. Mr. H. R. Kempe, "Telegraph History."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. C. A. Daubney, "American Architecture."

TUESDAY, MARCH 12...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. Mr. W. McDougall, "The Will of the People."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. R. Grant Brown, "The Use of the Roman Character for Oriental Languages."

Roman Studies, Society for the Promotion of, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Annual Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. T. R. Holmes, "Ancient Britain." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by Professor John Goodman, 1. "Roller and Ball Bearings," and "The Testing of Anti-Friction Bearing Metals." 2. Messrs. A. B. McDonald and G. M. Taylor, "The Main Drainage of Glasgow." 3. Mr. W. C. Easton, "The Construction of the Glasgow Main-Drainage Works." 4. Mr. D. H. Morton, "Glasgow Main Drainage: The Mechanical Equipment of the Western Works and of the Kinning Park Pumping-Station."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. B. D. Fox, "Railless Electric Traction."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. Alfred Watkins, "New Methods of Speed and Gamma Testing."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Sir Ernest Birch, "The Federated Malay States."

WEDNESDAY, MARCH 13..ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor E. A. Gardner, "Greek Sculpture."

Biblical Archæology, 37, Gt. Russell-st., W.C., 4.30 p.m.

Geological, Burlington House, W., 8 p.m.

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. G. de Haviland, "Materials used in the Construction of Aeroplanes."

St. Paul's Ecclesiological Society, Chapter House, St. Paul's, E.C., 8 p.m. Mr. A. W. Clapham, "St. John's Priory, Clerkenwell, and its Buildings."

Japan Society, 20, Hanover-square, W., 8.30 p.m. Professor K. Ito, "The Japanese Paintings Exhibited at the British Museum."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Professor A. C. Benson, "Realism in English Fiction."

THURSDAY, MARCH 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. E. A. Gait, "The Indian Census of 1911."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Professor W. Rippmann, "The Psychology of Spelling, with Some Proposals for its Reform."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Discussion on the Interim Report of the Tests Standing Committee on the Testing of Concrete, Reinforced-Concrete and Materials employed therein."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. Oman, "Wellington's Army, 1808–15." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. W. Bickerton, "Bird Studies by Land and Sea."

FRIDAY, MARCH 15...Royal Institution, Albemarle-street, W., 9 p.m. Mr. F. Soddy, "The Origin of Radium."

Engineers, Junior Institution of, 39, Victoria-street, S.W., 8.15 p.m. Mr. A. H. Weston, "Crude Oil Engines."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting). A. E. Gladwyn, "The Heat Value of Fuels."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Dr. Rudolf Diesel, "The Diesel Oil Engine, and its Industrial Importance, particularly for Great Britain."

SATURDAY, MARCH 16....Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Molecular Physics." (Lecture IV.)

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.15 p.m. (Graduates' Section.) Mr. C. S. Ross, "Hydroplanes and Skimmers."

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Journal of the Royal Society of Arts.

No. 3,095. VOL. LX.

FRIDAY, MARCH 15, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 18th, 8 p.m. (Cantor Lecture.) NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." (Lecture I.)

WEDNESDAY, MARCH 20th, 8 p.m. (Ordinary Meeting.) F. MARTIN DUNCAN, "The Work of the Marine Biological Association." P. CHALMERS MITCHELL, D.Sc., LL.D., F.R.S., will preside. The paper will be illustrated by lantern slides and by the cinematograph.

Further details of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, March 11th, MR. LUTHER HOOPER delivered the third and final lecture of his course on "The Loom and Spindle: Past, Present, and Future."

On the motion of the Chairman a vote of thanks was accorded to Mr. Hooper for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1912 early in May next, and they therefore invite members of the Society to forward to the Secretary on or before Saturday, March 30th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S.

In 1865, to his Imperial Majesty, Napoleon III.

In 1866, to Michael Faraday, D.C.L., F.R.S.

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S.

In 1868, to Mr. (afterwards Sir) Joseph Whitworth, LL.D., F.R.S.

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, etc.

In 1870, to Vicomte Ferdinand de Lesseps, Member of the Institute of France, Hon. G.C.S.I.

In 1871, to Mr. (afterwards Sir) Henry Cole, K.C.B.

In 1872, to Mr. (afterwards Sir) Henry Bessemer, F.R.S.

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., Member of the Institute of France.

In 1874, to Mr. (afterwards Sir) C. W. Siemens, D.C.L., F.R.S.

In 1875, to Michel Chevalier.

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal.

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., Member of the Institute of France.

In 1878, to Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

In 1879, to Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

In 1880, to James Prescott Joule, LL.D., D.C.L., F.R.S.

In 1881, to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin.

In 1882, to Louis Pasteur, Member of the Institute of France, For. Memb. R.S.

In 1883, to Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

In 1884, to Captain James Buchanan Eads.

In 1885, to Mr. (afterwards Sir) Henry Doulton.

In 1886, to Samuel Cunliffe Lister (afterwards Lord Masham).

In 1887, to HER MAJESTY QUEEN VICTORIA.

In 1888, to Professor Hermann Louis Helmholtz, For. Memb. R.S.

In 1889, to John Percy, LL.D., F.R.S.

In 1890, to Dr. (afterwards Sir) William Henry Perkin, F.R.S.

In 1891, to Sir Frederick Abel, Bart., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

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In 1892, to Thomas Alva Edison.

In 1893, to Sir John Bennet Lawes, Bart., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

In 1894, to Sir Joseph (afterwards Lord) Lister, F.R.S.

In 1895, to Sir Isaac Lowthian Bell, Bart., F.R.S.

In 1896, to Professor David Edward Hughes, F.R.S.

In 1897, to George James Symons, F.R.S.

In 1898, to Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

In 1899, to Sir William Crookes, F.R.S.

In 1900, to Henry Wilde, F.R.S.

In 1901, to His Majesty King Edward VII.

In 1902, to Professor Alexander Graham Bell.

In 1903, to Sir Charles Augustus Hartley, K.C.M.G.

In 1904, to Walter Crane.

In 1905, to Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.

In 1906, to Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

In 1907, to the Earl of Cromer, G.C.B., O.M., G.C.M.G., K.C.S.I., C.I.E.

In 1908, to Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

In 1909, to Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S.

In 1910, to Madame Curie.

In 1911, to the Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.

A full list of the services for which the medals were awarded was given in the last number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 13th, 1912; Lord Sanderson, G.C.B., K.C.M.G., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Ba, Maung, Additional Magistrate and Small Cause Judge, Mandalay, Upper Burma.

Brunton, John Robert, 305, Padiham-road, Burnley, Lancashire.

Dass, Bahadur Luchman, c/o B. N. Rutton, Oliver Commercial School, The Mall, Lahore, India.

Finot, Leo, F.R.P.S., 27, New Bond-street, W.

Lichtenstein, Meyer, J.P., Pretoria Club, Pretoria, Transvaal, South Africa.

Okura, Kihachiro, Aoicho Akasaka-ku, Tokyo, Japan.

Sprott, Ernest M., 123, Victoria-street, S.W.

Ward-Thompson, B., Wilpshire, near Blackburn.

Young, Simon J., M.D., Main and Franklin-streets, Valparaiso, Indiana, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Armstrong, Donald, Lieutenant (U.S. Army), Fort Williams, Maine, U.S.A.

Armstrong, Francis Tuttle, 565, West 113th-street, New York City, New York, U.S.A.

Engineer, Dhunjibhoy Temulji, Grant-road, Bombay, India.

Frere, Miss C. F., 67, Westbourne-terrace, W.

Gaye, William Charles, H.H. the Nizam's Guaranteed State Railway, Secunderabad, Deccan, India.

Mohammad, Professor Khwaja Dil, M.A., Islamia College, Lahore, India.

Napier, Robert West, 26, Bruntsfield-place, Edinburgh.

Pillow, Mrs. Margaret Eleanor, "The Grange," Thorpe-road, Norwich.

Tok, Maung Po, Tharrawaddy, Burma.

Traill, George, "Colwyn," Redington-road, West Heath, Hampstead, N.W.

Worth, Joseph Henry, Tongku, North China.

The paper read was—

GREEK SCULPTURE.

By Ernest A. Gardner, M.A.,

Yates Professor of Archæology, University College, London.

When I was invited to read a paper on Greek Sculpture before the Royal Society of Arts, I felt some difficulty in deciding what line to adopt in dealing with so vast a subject in the course of a single hour. Any theoretical or historical discussion could only be of the most summary character. On the other hand, a purely technical treatment must be assigned to a practical sculptor, unless it is to consist mainly of second-hand information. Perhaps a reasonable compromise may be found if we consider this evening the conditions under which the Greek sculptors worked, and which contributed to the extraordinary excellence they attained in their art; and, secondly, the conditions under which their work has come down to us; for these often make the understanding and appreciation of ancient sculpture very difficult to us in modern days; and the second of these two may best be considered first, for it is necessary, as a preliminary measure, to remove some prevalent misapprehensions as to Greek sculpture.

The first disadvantage under which we suffer is that we see Greek statues not in the setting for which they were originally designed, but in the halls or galleries of modern museums. Some of

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these, though built expressly for their purpose, and in many ways well enough adapted to it, are uninteresting and uninspiring, a complaint sometimes brought against our own British Museum. Others, such as the Louvre at Paris, and much of the Vatican at Rome, were never designed as sculpture galleries, and leave much to be desired in the way of space and lighting, though they seem to give a romantic and picturesque setting to the sculptures and reliefs that decorate them. We may well, from a purely aesthetic and sentimental point of view, regret the days when the relics of ancient art were scattered about as the ornaments of villas and gardens—such may still be seen in some places; but it must be admitted that, while this arrangement may be admissible for works of little artistic or historical value, we are not now justified in exposing to the wasting power of the weather, and to other chances, statues that cannot be replaced and that may be the only records of a lost phase of art. I do not think the authorities of museums, or anybody else, are to be blamed for this contrast of conditions; it is inevitable, not so much from any difference of purpose or of climate, as because, to us, these statues must be guarded against any unnecessary risks of damage from weather or other causes, because we regard ourselves as responsible for their safe transmission to our successors. To the Greeks of the best period they were the products of a living art, which was still capable of producing as good or better; they cared more about their being seen and appreciated by their contemporaries than about any influence on the life and art of a generation more than 2,000 years removed. At Athens, at Olympia, at Delphi, the sacred precincts were peopled by thousands of statues in marble and in bronze, which, in the clear and luminous air of Greece, were seen as they never can be in any modern museum.

If such a setting is needed for the appreciation of individual statues, how much more is it the case with the architectural sculptures, such as those which once decorated the Parthenon, and now are arranged in the Elgin Room of the British Museum! Apart from their massive architectural frame, from their relation to one another, and to the temple as a whole, these sculptures are only partially intelligible, and lose a great deal of their effect. Yet what is now possible for us, except to arrange them in such a way as to suggest their original position and composition? It has, indeed, been suggested that the Elgin marbles, now that Athens is a place of safety, should be returned to Greece and replaced in their original surroundings. Apart from sentimental considerations, we have to face the question of what would be done with them if they were so returned at the present day. There can, I think, be no doubt that they would be placed in a museum at Athens, and that, though they might have better light and clearer air, they would be no more seen under the original conditions than they are now. They could not be replaced in their original positions in the Parthenon unless the building were entirely reconstructed; and, even if this course were taken, they would be so much exposed to damage from weather that it would probably be considered unjustifiable to leave them thus unprotected; for the force of weathering is not merely cumulative, but rapidly increases in its disintegrating effect. Although, as Plutarch testifies, the Parthenon suffered remarkably little in its first 500 years, the same cannot be said of the succeeding 1,000, or even of the time since 1800 A.D., to judge from Elgin's casts. We have to be content to see such portions of the sculpture as are still left on the Parthenon and the Theseum; and these are most valuable, for example, in exposing the fallacy that they could not be seen properly when in their places. But, even if complete restoration were attempted, casts would have to take the place of the original sculptures, which must always henceforth be protected from damage or weathering. An interesting example of the restoration of the original setting of a great series of architectural sculptures may be seen in the exhibition of the Pergamene sculptures at Berlin, where the whole of the great altar to which they belonged has been reconstructed and placed bodily within a modern building to give it shelter. Such a proceeding is not always possible. But enough has been said to show how, in every case, we must exercise our imagination to realise the conditions under which works of ancient sculpture were originally meant to be seen, and to appreciate them in relation to those conditions.

Next to this question of exhibition comes the question of restoration. Here, again, the older practice was fairly simple. So long as statues were regarded as objects of decoration rather than as records or monuments for historical or artistic study, they were usually completed if incomplete when they were found; their whole surface was worked over to give them a fresh and white appearance; missing limbs or heads or bodies were replaced either by old ones that

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could be made to do, or by new ones after the restorer's phantasy. In some cases, no doubt, the restorer was influenced, consciously or unconsciously, by other statues of a similar type which he had seen, and so made some attempt at what we should now call a scientific restoration. But more often he worked at haphazard, and the older collections, such as the Vatican or the Louvre, are full of his products, which often have but the slightest claim to any connection with ancient art. I will give one example to illustrate this from the Louvre catalogue, No. 224.

"The young Bacchus, nude, his left arm resting on the thyrsus, offers with his lowered right hand a bunch of grapes to a panther seated at his feet. . . ."

(*Modern*, the head of Bacchus and most of his hair, his right fore-arm and elbow, left fore-arm and thyrsus, a portion of right thigh, both legs and feet, the panther and the plinth.)

"Charming statue in white marble."

Yes—but whose statue? Surely the Italian restorer's. It would be easy, but not instructive, to multiply such examples. I will only quote one more case—that of the Tyrannicide Aristogeiton at Naples, whose dry and muscular figure, characteristic of the transitional age, is given an almost grotesque effect by the addition of a Lysippean head of sentimental type. The change in practice really dates from early in the last century. When the Æginetan sculptures were taken to Munich, the sculptor Thorwaldsen was employed to restore them, and he did it with so careful an imitation of the style and even of the weathering of the extant portions that it is now very difficult to tell what is his work and what is ancient. Canova was asked to do the same for the Elgin marbles, and, to his lasting glory, he replied that it would be desecration for any modern hand to attempt to restore such works—an opinion which has since, happily, prevailed. It is not merely that the restorer adds something of his own which may or may not harmonise with the original. But if he restores in marble, he must necessarily cut away many projecting portions that might have given a clue to the position of missing limbs, and he must also almost inevitably destroy the original surface in an attempt to make the old and the new harmonise in appearance. If neither of these be done, and restoration be made in plaster only, whether of the original or of a cast from it, no harm is done by restoration, and it may be instructive; and under these conditions it is in no way inconsistent with modern scientific and historical study; but the originals must always be sacred from any cutting or polishing away.

Another condition that adds to the difference between works of Greek sculpture as the Greeks saw them and as we see them at the present day, is the absence of colour. It is a common opinion —I am inclined to call it rather a popular fallacy —that sculpture is the art of abstract form, and that any addition of colour to mar its perfect whiteness is a defect and a distraction. The historical origin of this delusion is easy to trace. Greek sculpture was always coloured to some extent in the best period, and so was mediaeval sculpture. But when the cult and imitation of "the antique" set in at the Renaissance, the Greek and Græco-Roman sculptures which either had remained above ground or were dug up out of the earth had lost all the colour they once had; and hence there arose the notion of colourless white marble as the proper material for sculpture. The result is not only that unrelieved glare of the surface which, especially in a bright southern light, dazzles the eye and makes it incapable of appreciating refinements of modelling, but also that absence of detail, that blankness of expression, especially in the eye-balls, which makes so much ancient and modern sculpture void of meaning and character to the modern spectator. As a matter of fact, the custom of adding no colour to marble and giving it a high polish, probably in imitation of bronze, did come in among certain later schools of ancient sculpture; but when they gave up colouring the iris and pupil of the eye, they also took to rendering these in some way in relief, whether in a purely conventional imitation of the natural forms, or by an impressionistic method such as is now favoured by modern sculptors. The actual practice of the ancients in this matter was for a long time a matter of conjecture; and there were a certain number of people who, in the absence of definite evidence, clung to the old prejudice against the application of colour to marble, and preferred to believe that the Greeks could not have done a thing that seemed to them tasteless and barbaric. But the discoveries of recent years have yielded us a good many examples of ancient sculpture still retaining its original colouring, or at least sufficient traces of it to enable us to realise what that original colouring was like. Notably, we have the series of early architectural groups in soft limestone from the Acropolis of Athens, the series of early female statues in marble from the same site, and the wonderfully preserved sarcophagus from

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Sidon, especially the so-called Alexander sarcophagus. And these sculptures show us the effect of colour as applied to stone and marble, both in the early days of Greek sculpture and during its most advanced period. If we set aside the early sculptures in rough limestone, in which a complete and opaque coat of colour hid the inferior texture of the material, we find that the application of colour is both conventional in its scheme and limited in its application. The usual rule, for sculpture as for architecture, is that the broad structural masses are left plain, and that details only, such as the borders of garments, hair and lips and eye-balls, are coloured; and when colour is applied in this way, so far from obscuring the beautiful texture of the material, it enhances it by contrast. The gain in expression when the iris and pupil of the eye are thus indicated, may best be appreciated in the heads from the Alexander sarcophagus, and with their help we can realise in imagination what other Greek heads of about the same date ought to look like. In addition to this painting of details, we also find that the whole surface of the flesh parts, for example, was toned down or polished, sometimes with some addition of a colour or tint. In this case the colour is not opaque but transparent, and again makes it easier, not more difficult, to appreciate the texture of the material. I think it is a suspicion that paint is used to conceal an inferior material which is responsible for much of the prejudice against coloured sculpture.

But even after we have realised in our imagination what any work of Greek sculpture was like when it left the sculptor's workshop; when we have allowed for the conditions under which it was meant to be seen, and have eliminated in our mind not only the ravages of time, but the additions and modifications of the modern restorer, we have still to consider whether it is an original Greek work or a copy, made in all probability for the Roman market. There is an immense number of such copies in all our museums, and in many cases the masterpieces of the great sculptors of the fifth and fourth centuries—of the age of Phidias and Praxiteles—only survive for us in this form. The difference between a copy and an original work is always great; but it varies considerably according to the period when the copy was made and other conditions. It may be said, in general, that a copy of Roman date, while it is more likely to aim at mechanical accuracy, is less likely to catch the subtler qualities, the spirit and character of the original; while a Greek copy or replica, whether contemporary with or later than the work it reproduces, is likely to give us a truer notion of these subtler qualities, even though it be less faithful in details and accessories. An excellent example is offered by the head of the Meleager in the garden of the Villa Medici, as compared with the Græco-Roman version of the same in the Vatican Meleager. This is a matter in which one or two actual examples are more instructive than any amount of description. As another example we may take the Agias, a contemporary replica of a statue by Lysippus, in comparison with the Apoxyomenos, probably a Græco-Roman copy of a Lysippean work.

If, however, we would appreciate and understand the essential differences between ancient and modern sculpture, we must not only consider all these external and more or less accidental conditions and relations, but also the conditions under which the ancient Greek sculptor actually worked. Here, what might at first sight appear to be his restrictions and limitations were really his strength. He was bound by tradition and convention to a degree which is hard for us to realise. But, instead of allowing this convention to strangle his art, as was the case with the artists of Egypt and Mesopotamia, he made it serve as a channel to keep in a deep and vigorous stream the artistic impulse which else might have been diffused to no purpose. We find, in fact, that he repeats again and again, with what seems at first an almost wearisome monotony, a limited number of fixed types. But such a repetition of types is by no means always a sign of weakness in art; we have only to think of the iteration of familiar types, such as the Madonna and Child, in Mediæval and Renaissance painting. It is not, however, a merely mechanical repetition; for the early Greek sculptor was constantly observing nature and striving to embody the results of his observations in his repetitions of the well-known types. We can see this most clearly if we take one only of these types, that of the nude male standing figure, and follow out its development in some detail. In its origin this type was evidently borrowed from the common Egyptian type; but it was used by the early Greek artists, in a practically indistinguishable form, to represent a god in a temple—above all, Apollo—a victorious athlete, or a conventional portrait of the deceased set up over a tomb. But the type as we may see it, was not merely conventionally borrowed. It was repeated again and again from the trained memory of the artist, and this trained memory,

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by ascertained psychological rules, retained only two aspects of the figure, the full face and the profile; but at the same time he was able to produce his figures, working freehand from memory, with an extraordinary degree of certainty and facility. He was thus able to dispense not only with a posed living model before him as he worked, but also with any full-sized model of clay or other material to guide him in his work. Small workshop models, or sketches in wax, may, of course, have been used. But it was, above all, on his memory, and on a memory reinforced by family and school tradition, that the sculptor depended. Again, he was able to dispense wth a poised living model because he constantly had before him the living body in exercise in the gymnasia and wrestling schools that were constantly frequented by all the men of the state; the custom of athletic nudity thus gave the sculptor an opportunity for study of the living and moving athletic form such as never has existed before or since; and consequently it is above all in the nude male figure that the Greek sculptor excels; but the restriction to a few clearly-defined poses enabled him to concentrate all his attention upon the improvement in proportion and in detailed modelling; freedom of pose came later. We might easily follow the same line of development in other types—the draped female figure, for example, where the beauty and sculpturesque fitness of the clothes worn in ordinary life obviated the necessity for draping a posed model in unusual garments; or the flying victory, the wounded warrior, or other less obvious types, each developed on its own special lines.

It was by such means as this that there was built up a series of types, a basis of naturalism that offered a firm foundation for the idealism of the fifth century; and though this basis was modified to some extent by later realism, it was never completely lost. Even later Greek art, though it freed itself from the trammels of early convention, never substituted for it the complete anarchy we too often find in modern work. As a result, it may sometimes lapse into the somewhat lifeless tradition of the later classical age; but at least it preserves even then much of the character of the great period of Greek art, so that it was possible for men like Lessing and Winkelmann to recognise in works like the Laocoon and the Apollo Belvedere those essential qualities of Greek sculpture for which we prefer to go to the Elgin marbles.

DISCUSSION.

THE CHAIRMAN remarked that he supposed there were two subjects upon which almost every individual thought he was able to express an opinion, however little he might have studied them; one was politics and the other was art. He further supposed every individual must have some kind of taste, although open to the risk, perhaps, of being like a certain illustrious person of whom it was said he had a great deal of taste, and it was, all of it, bad. He (the Chairman) reflected when he had been invited to take the chair on the present occasion that his recollections and knowledge of Greek sculpture were not altogether absent but somewhat hazy, and he therefore did what he always did in a difficulty, went to the British Museum. That institution happened to be closed in consequence of certain occurrences to which he need not further refer, but he was received with great civility by Mr. Arthur Smith, the Keeper of Greek and Roman Antiquities, who was kind enough to take him to see the collection of casts illustrative of Greek and Roman art. On the way he was shown a new acquisition to the Museum—a bronze head of Augustus, with the pupils of the eyes painted, and that addition was very remarkable and striking. As Mr. Smith took him over the collection of casts—photographs of many of which had been thrown on the screen that evening—what had struck him most forcibly was the great suddenness with which Greek art seemed to have blazed into what was considered perfection. Firstly, there was the "Gate of Lions" from Mycenæ, of which Edmond About remarked irreverently that it reminded him of the pictures he had drawn as a boy on his slate, adding the epigram that the childhood of art was very like the art of childhood. Then followed a series of rather stiff sculptures, all slowly struggling towards Nature and endeavouring to put on a not very attractive style. Then suddenly Myron produced a statue of a cow, about which little was known except that it was a very beautiful cow, and also a man throwing a discus, which were full of life and action. From that one came into the age of Phidias, whose incomparable work all admired. What was remarkable about that transition was that it did not take place in a time of great peace and quiet, when the people could devote themselves to peaceful art, but it happened at a time of unrest. The Greeks had been overrun by the Persians and with great difficulty had driven them out. Thereupon there was a kind of ebullition and it seemed to him as if the Greeks at the same time as they threw off the Persians also threw off the Oriental influence and developed their own art. Turning to the author's observations on the question of surroundings, he thought all must agree that upon the whole it was not a matter of which we should repent that a certain number of the best specimens of Greek art should be safely housed in our museums; but it was quite

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clear the surroundings were such that the full value of the specimens could not be appreciated. For instance, when one stood in the Ephesus Room of the British Museum, it required a good deal of imagination to reconstruct in the mind's eye the original scene. On one side were the sculptured drums forming the bases of columns, and on the other side was an enormous capital of a column, and one had to erect in one's mind a series of tremendous columns with the statues all round, which was an extremely difficult thing to do. He had always thought when one of the great exhibitions was being constructed that it would be well worth while to attempt to reproduce such a thing as the Temple of Ephesus. The Temple of Ephesus could not be reproduced inside the Museum but it might be erected outside. He, however, supposed the cost would be prohibitive. When he was a boy at school he was always taught to believe that the beauty of the Phidias chryselephantine statue of Athene in the Parthenon was most magnificent, and he confessed he was thunderstruck when he went to the British Museum and saw what seemed to be a dumpy-looking statuette with its helmet covered with almost Indian-looking ornaments. He presumed that was an indifferent reproduction. Again, he thought it would be an excellent thing if in one of the great exhibitions there was a reproduction of that great statue on its pedestal forty feet high. That led him on to another point which was, perhaps, a little outside the scope of the lecture. On the question of surroundings, he did not think it was often considered how very much our own public monuments, upon which so much criticism was showered, suffered from the circumstances in which they were placed. With a murky atmosphere, with a background of grimy buildings, and with a climate which insisted upon half tints, and which made high colouring and brightness look crude, it was almost impossible that statues could really have their full effect; and he had often thought, as he had stood by some of those which were most criticised, that if they had been put somewhere else, say in Italy or in Germany, they would have been thought much more highly of. He remembered during a discussion the late Duke of Devonshire saying, "I suppose if the Albert Memorial had been put up somewhere a great many miles off in a foreign country, we should go in crowds to look at it." No doubt there were many who would dissent from that view, though to him (the speaker) the Albert Memorial seemed not far short of a very fine work. Upon the whole, considering the difficulties under which they laboured, and the fact that they had not the opportunity of seeing a number of people constantly running about with very few clothes on, and that they had such a climate to work in and to exhibit their works in, it was a matter of surprise that our sculptors turned out such fine work as they did. The author had kept those present that evening in a fairy-like country, where they had been able to think of other things than their own material interests, and he had given them a great deal which was very suggestive. No doubt, if experts had been present there might have been a lively discussion on the question of colouring and tinting of statues. He (the speaker) was not quite certain whether—at all events, in northern countries—it was possible to introduce colouring to the extent to which it could be introduced in brighter atmospheres, but there could be no doubt that the Greeks did use colouring, and that they admired it very much. He had the greatest pleasure in proposing a hearty vote of thanks to the author for his interesting paper.

Professor Gardner, in replying to the suggestions of the Chairman, said he certainly thought that everybody who had studied the history of Greek sculpture must have been immensely impressed with the fact that the progress in the art had been extraordinarily rapid during the fifth century. But art had a way of progressing in that extraordinarily rapid manner at different times. In the same way the progress of art in Florence at the time of the Renaissance was most rapid for a certain time. There seemed to be a kind of wave that came over the artistic spirit which carried artistic production far beyond its previous limits, and if one or two men of supreme genius appeared at the moment it would be found they reached an attainment which was quite incredible when compared with the work of a very short time before. There was no doubt the connection between the improvement in the art of the Greeks and their defeat of the Persians was very close indeed. It was an immense inspiration to the Greeks. Previously they had regarded the great Oriental monarchy as a thing to be looked up to, but when they found they could beat the Persians in war—which might not be the highest form of victory, but it was the only form of victory we knew—and when they found that they, as a free people, were actually able not only to hold their own, but to defeat an immensely greater army, it gave them a dignity and self-respect, and a power of idealising themselves and all that belonged to them which contributed enormously to that wonderful development which had taken place. With regard to the practical suggestions, he should very much like to see them carried out in connection with exhibitions. As the Chairman had said, it was impossible to re-erect the Temple of Ephesus in the British Museum. An attempt had been made to re-erect a portion of the Mausoleum, but that was only a very small portion, and only small pieces could be re-erected where an opportunity offered. The forms of the Temple at Ephesus were so well known that it might be possible to erect a copy of that Temple, and he would be intensely interested to see it carried out. Something had been done towards restoring the great monuments of Roman times. A very interesting experiment had been made in connection with the temple of Zeus. He thought Quatrénien De Quincy had designed a very

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interesting restoration of that in gold and ivory. He did not know himself what had become of it, but it was an attempt on a fairly large scale. He sincerely wished that some such experiments could be tried in connection with the various exhibitions which were held from time to time.

THE BURMESE SILK INDUSTRY.

The natives of Burma, both men and women, wear, for the most part, costumes of silk. The costume of the men consists of a long skirt, extending from the waist to the ankles, called a "longyee," a collarless shirt or "chway-gan," over which is placed the "aain-gyee," a short coat, and a silk handkerchief is tied round the head. This costume is usually of highly-coloured silk, the favourites being pink, red, and watered silks. The coat is often of white silk covered with embroidery. The cost of these costumes varies according to the quality of silk used. The women's costumes are similar to those worn by the men, except that the skirt is much tighter, and the silk handkerchief, instead of being tied round the head, is hung around the neck, with the ends extending down the front of the body as far as the waist. The women do not wear any shoes or stockings, going either barefoot or with sandals without heels. The men of the present generation have adopted European shoes and hose, but cling to the rest of the native dress. Notwithstanding the almost universal use of silk by the Burmese, the cultivation and manufacture of silk have not been a financial success in Burma. Raw silk could be more extensively produced in Burma, according to the American Consul at Rangoon, were it not for the fact that the Burmese population, being Buddhists, dislike to undertake the cultivation of the silkworm, because the pupæ of the insects have to be killed by boiling before the reeling of silk from the cocoons. Raw silk is, therefore, mostly imported from China and Japan. Small quantities of native raw silk are, however, produced within the province. This silk, which is of dull yellow colour, is boiled in water about six hours, until it becomes white. While still moist, the silk is spun on to wooden wheels, from which, after drying, it is transferred to the dyeing vats, where it is steeped and boiled again for another hour. German aniline dyes are used. An alkaline substance called sopaya (soap) is boiled with the dye. After drying in the sun the silk is reeled again. It is then unravelled on to a hexagonal frame supported on six uprights, called a "kya," from which it is transferred to the loom and woven by hand. About five days are taken to prepare the silk from the raw state for the loom. The silk is woven into paseos (men's cloths) or loongies (women's cloths). The Chinese raw silk, called "my-pah," occurs in skeins, twelve of which form a bundle, and fifteen bundles a load, weighing from 126 to 132 pounds. Like the local silk, it is of a dirty yellow colour, which turns to white after boiling. A viss (three pounds ten ounces) is said to be reduced to three-fourths of a viss by being boiled. This raw silk is worth from twenty-five to thirty shillings per viss before boiling, but goes up to thirty-seven shillings and sixpence after boiling. It takes a man, working steadily, about five days to weave a paso nine yards long. Usually, however, he and his family work at the loom intermittently, so that a loom of silk (fifty-four yards) takes, on the average, about two months to weave. A paso of nine yards is worth from ten shillings and sixpence to seventeen shillings and sixpence. The cheapest paseos are, however, only four yards long, and sell at about eight shillings and twopence each. The width of a paso varies from fourteen to twenty-two inches. The spinning and weaving are done in the homes of the natives. Often the weaving is performed in the yard, or along the road under a thatched shed. The weavers usually work for themselves, producing the fabric as it pleases them, and sell it at the rates named. Sometimes, however, weavers are hired by Chinese or Burmese brokers at the rate of about fifteen shillings and sixpence per fifty-four yards. There are no fixed hours of working, weaving sometimes proceeding all day and part of the night, more usually for only a few hours of the day. There is no system or steady application to work. Future prospects of the silk industry in Burma are said to be poor, unless the industry be encouraged by outside demand, or restored by the introduction of new and improved methods of production and manufacture. The Burmese silk is much coarser and heavier than the Chinese and Japanese silks, which are coming into more general use by the natives on account of their finer qualities, more brilliant colouring, and cheaper price. During the calendar year 1910, raw silk, valued at about £197,000, and manufactured silk, valued at about £364,000, were imported into Burma, chiefly from China and Japan.

OSTRICH FARMING IN THE UNITED STATES.

The United States Department of Agriculture has issued a report on the ostrich industry in that country, which shows that in January, 1910, there were at least 6,100 breeding or feather-producing ostriches in the United States, of which Arizona had 80 per cent., California 17 per cent., the remainder being in Texas and Florida. The question of the nature of the country most favourable for ostriches is largely affected by the kind of vegetation peculiarly suited to the soil, which in turn is undoubtedly affected by the amount of rainfall. Alfalfa pasture makes an ideal run for the birds, furnishing a large percentage of their food; hence a soil which is, or can be, made suitable for alfalfa is one of the essentials to ostrich farming. It has been demonstrated that various parts of the United States are adapted to ostrich

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breeding, and now that the results of experience have shown some of the ways in which ostrich farms may be managed successfully, there is every reason to believe that there will be a steady and marked growth in the United States ostrich industry in the near future. The demand for literature, and the number of inquiries received by the United States Agricultural Department for information concerning ostriches, indicate that the number of individuals who are interested in ostrich farming is rapidly increasing. The profit to be derived from the business will depend on the management, on the success secured in the breeding of the young birds, and on the production of feathers of good quality. The average annual yield of feathers from an ostrich is one pound and a quarter. Birds produce from twelve to twenty ounces of feathers at each plucking, with an average of sixteen ounces. The total weight of an average yield is divided roughly as follows:—"Wings," 48 per cent.; "short stuff," 25 per cent.; and "tails," 27 per cent. The amount received from the feathers of each bird varies from £4 to £6, depending upon the yield and the price of the product. The average return during the year 1909 was a little over £5 per bird. While both ostrich eggs and flesh may be used for human consumption, the amount to be derived from these products is hardly worth considering. As each pair of breeding birds is worth about £160, and chicks six months old are valued at £20, any deaths from accidents, or any inability to raise chicks greatly lessens the profit to be derived from the business. Allowing for some loss in this way, and charging a fair interest on the investment, the business can be run, it is said, to return a fair profit. The United States is reputed to be one of the greatest feather-buying markets in the world, and the amount of sales in that country has a very perceptible influence on the price. With such a market at hand, the obviously sound reasons for ostrich farming on a proper scale in the United States require no demonstration.

THE PROTECTION OF CROPS FROM HAIL.

The protection of crops from damage by hail has for some time occupied the attention of agriculturists and scientists in France. Good results have, in some cases, been obtained by the discharge of explosives during thunderstorms, but the practical working of the plan leaves much to be desired. In many cases the storm comes on too suddenly, the hail begins to fall before the gunner is at his post, and the damage is done before the firing can be commenced. The problem appears to have been solved by General de Négrier and Count de Beauchamp, by an apparatus which is at the same time simple and automatic. It is based on the fact that hailstorms are always associated with electrical disturbances. The ordinary lightning-rod, which exerts its influence over a very limited area, is quite insufficient for the protection of even a single field. A more powerful means of establishing equilibrium between the electrical conditions of the earth and atmosphere must be used.

The apparatus designed by MM. Négrier and Beauchamp, which they term "Niagara Eléctrique," appears to fulfil this condition. Its principle, which is the same as that of the lightning-rod in common use, consists mainly in a terminal or "Niagara" (so-called by the inventors), the conductor and the diffuser. The first serves, as it were, to tap the thunder cloud, and draw off the electric fluid, which passes to earth by means of the conductor. This terminal, which is made of chemically pure copper, on account of its high electric conductivity, consists of a number of points or spikes arranged round a central rod. It may be made in any suitable ornamental form, such as an aloe. This is usually made with a removable collar, to place round the cross or weather-cock of a church tower. The terminal may be placed on the summit of a church tower, factory chimney, or other high building, at a height of at least ten metres (33 feet) above the top of the highest trees in the neighbourhood. The conductor, which is made of copper plates five to eight centimetres (2 to 3¼ inches) wide, and two to two and a half centimetres (¾ to 1 inch) thick, is attached to the terminal. It should be enclosed in a lead casing to prevent oxidation, and properly protected from the weather. Care must be taken, in fixing the conductor, to avoid sharp curves and sudden turns. To the lower end of this conductor is attached the "diffuser." It is also of copper, silver-plated, and is placed in a well, running stream, pond, or underground watercourse.

The first apparatus was fixed by Count de Beauchamp, eleven years ago, on the church tower of Saint-Julien-l'Ars, in the department of Vienne, to protect his property, which, prior to this, was frequently visited by severe storms. The height of this tower is sixty metres (197 feet). The effect of this first station has been excellent, and, according to the reports of the mayor and curé of the place, no serious damage to the crops from hail, or persons or animals struck by lightning, have occurred within the protected area since it was first established.

A second station was established about three years ago, and an apparatus fixed on the tower of the church at Chauvigny, about ten kilometres (6¼ miles) off, at a height of fifty metres (164 feet), with equally satisfactory results. Chauvigny, in the valley of the Vienne, dominates an extensive arid plain formerly ravaged by hail. The third is fixed on an iron latticed post, forty metres high (131 feet), and was erected by General de Négrier at Paizay-le-Sec, in the same department. Finally, a fourth was established at Saint Sauvin, on the church tower, which is one hundred metres (328 feet) high. As the last is situated in a deep valley some sixty metres below the others, the level of the terminals of the four stations may be considered as practically the same.

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A line drawn through these four stations, which are about six miles apart, forms a kind of barrier or dam (*barrage électrique*), which effectively stops the passage of the electrically-charged storm clouds, which, in this district, as is generally the case in France, come from the south-west.

This barrier, which has now been working about three years, has given excellent results, as is proved by the official reports of the local authorities, the statement after each storm being invariably "no damage" (*dégats-néant*). No hail is formed within the protected area, and hailstones, which may have been formed at some distance beyond the barrier, melt at once, without doing the slightest damage, as soon as they enter the protected zone.

It has been found, in practice, that the effect of the "Niagara" is exerted for a distance of between four and five kilometres (2½ to 3 miles) on the side of the barrier to which the storm clouds are moving, whilst on the windward side of the imaginary line between two stations its influence only extends from half to a kilometre (say three-tenths to three-fifths of a mile). In localities where storm winds may be expected from various quarters, the positions of the stations must be so arranged as to give complete shelter.

Notwithstanding that thunderstorms were very numerous and violent during the first half of last year, the crops within the protected area have not suffered. Beyond the influence of the barrier they have been severely damaged. The official reports from the mayors of Saint-Julien-l'Ars, Chauvigny, and Paizay-le-Sec, are unanimous as to the efficiency of the system, and of no damage being suffered by the crops in these districts.

A permanent committee (*Comité de défense contre les orages et la grêle*), with headquarters at Paris, has been formed, for promoting and advising on similar undertakings. A favourable report on the working of the system in the valley of the Vienne, was given in a mémoire by Professor Violle, to the Académie des Sciences, Paris; and, last year, M. de Pontbrian, senator, in a report to the agricultural department of the French Senate, strongly recommended the establishment of other "Niagaras paragrêles," to prevent damage to the vineyards and other crops by hail, in other parts of France. Other barriers are projected, and probably will be erected in various other parts of the country.

It is probable that, before long, the Eiffel Tower will be utilised as a station for this purpose, and towards the cost of this a subvention has already been granted by the Municipality of Paris. If this were done, and other stations established at the Panthéon and on the church of the Sacré Cœur at Montmartre, the whole of Paris would be effectually protected from thunderstorms.

Under ordinary conditions the cost of establishing one of these stations on a church tower, or other high building, should not exceed 2,500 francs (£100). For the protection of a large district, it is estimated that the cost would not exceed one franc per hectare (about 4½*d.* per acre).

THE JUNGFRAU RAILWAY.

The successful piercing on February 21st last of a tunnel at an altitude of 3,457 metres (11,339 feet) is an achievement which reflects great honour on Swiss engineering skill and enterprise. By the completion of this work the railway will be extended to Jungfrau Joch, where it emerges from the tunnel amidst the glaciers and perpetual snow of this lofty mountain range about 2,305 feet below the summit of the Jungfrau.

The Jungfrau railway planned by Professor Gollioz in 1895, and commenced two years later under the auspices of the Swiss railroad magnate, the late M. Guyer-Zoller, was opened for traffic as far as the Eismeer station in August, 1905. It is worked by electricity on the rack and pinion system; the gauge is one metre, and its maximum gradients are as steep as 25 per cent. (1 in 4). Starting from Scheidegg at an altitude of 2,064 metres (6,770 feet), the line ascends through pastures for a distance of about 1¼ miles, and after passing a short tunnel 92 yards in length, reaches the Eiger glacier station 7,640 feet above the sea level. The line then skirts the face of the cliff to enter a long tunnel, emerging at Rotstock (8,300 feet) at the second mile, and Eigerwand (9,406 feet above sea level) a quarter of a mile further. From hence the railway tunnel is carried on to Eismeer station (10,315 feet), a distance of 3½ miles from the starting-place at Scheidegg.

Eismeer, the present terminus of the railway, is an excellent starting-place for ascents of Mönch, Eiger, the Jungfrau, and other peaks. From this point, the line in construction to Jungfrau Joch (11,090 feet), and its extension to the terminus situated at an altitude of 13,428 feet, is mostly in tunnel for a length of about 3½ miles. The terminus will be connected with the summit, which is 4,160 metres (13,644 feet), by a lift. The total length of the railway from Scheidegg to the top of the Jungfrau is 7½ miles. About two hundred Italian miners and other workmen have been incessantly engaged for the construction of this part of the line during the last four years, in this Alpine region where the thermometer frequently registers 25° below zero C. (13° below zero F.). The temperature in the tunnel, however, never falls 3° below zero C. (26½° F.).

Eventually, it is intended to extend the line down the other side to reach the Rhône valley, and from thence to join the Simplon railway near Brieg. This would partly be worked by a cable line.

THE TONKA BEAN INDUSTRY IN VENEZUELA.

The tonka, tonqua or tonquin bean of commerce is supposed to have first reached Europe from the Province of Annam, Tonquin. It is the dried seed of the fruit of the leguminous tree called by botanists *Dipteryx odorata*, which grows in the forests of the northern part of South America. The tree attains a height of eighty feet, and the fruit

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is an oblong, fibrous pod that contains one seed, almond-shaped but larger, and covered with a shiny black skin. The seeds have the sweet odour of new-mown hay. Tonka trees flourish in the Guianas, in the State of Para, Brazil, and the Orinoco basin of Venezuela. The best beans come, it is said by the International Bureau of American Republics, from a district in the vicinity of the Caura and Cuchivero Rivers, where yearly migrations of the natives convert the usually silent forests into populous localities. In the country watered by the Orinoco and its tributaries, several granite mountain ranges cross, with an average altitude, exclusive of isolated peaks, of between 3,000 and 4,000 feet. The land in the vicinity of these ranges is largely composed of detritus, in which powdered granite is present in high percentage, and this seems to be the soil best suited for the tonka-bean tree. The tree is found scattered singly throughout the forest, rarely in groves. Experience has shown that the third-year crop is generally the best, although it is almost impossible to forecast the harvest of any one year. In Venezuela the tree is known as the "Serrapia," from which the men engaged in collecting the beans earn their name "serrapieros." Early in February these men begin to arrive on the Caura from Ciudad Bolivar, or even farther distant. The old hands know every tonka-bean tree in the district, and usually confine their labours to the serrapiales with which they are familiar. Some of the more energetic of the men strike out to the untried regions, but the rapids of the upper river make such trips dangerous. When a suitable spot has been selected from which to begin operations, the men immediately build the ranches or straw houses that serve for headquarters during the two or three months following. If the fruit has commenced to fall, the men begin collecting the beans at once, otherwise they wander in the forest, marking places where the fruit is plentiful, or spend the time in hunting or fishing. Men, women, and children all take part in the collection. The fruit is much like the mango in appearance, and serves as food for the natives. It has but little pulp, which is sticky and of insipid taste, while the seed is covered with a hard fur-like substance. When the serrapiero has gathered sufficient fruit, he carries it to some open spot in the forest where he can get the benefit of strong sunlight; he here carefully breaks open the hard shell and extracts the single oblong, dark-brown bean. The seeds are then spread to dry on large granite slabs common in Venezuela. The dried beans are then shipped to Ciudad Bolivar and sold to local merchants, who may subject them to the process called crystallisation, or who may send the beans on to Trinidad, where this process can be carried on much more cheaply. Crystallising is an alcohol treatment. Open casks are ranged side by side and filled with beans to within one foot of the top. Strong rum is then poured over them until the casks are quite full, then they are covered with gunny bags. At the end of twenty-four hours the rum not absorbed is run off, and the beans are spread out to dry where the air circulates freely. When first emptied from the casks the beans are of a dull black colour, soft and swollen, but, on drying, shiny white crystals appear on their surfaces, and by the time they are ready for packing they seem to be sugar-coated. The beans shrink in drying, and present a wrinkled appearance when ready for final exportation. Tonka beans, pulverised, are mixed with snuff and tobacco to give a bouquet, and their sweet scent finds them a ready market with perfumery and soap manufacturers. Sometimes they displace the vanilla bean, but strictly speaking it is the fragrant odour that gives value to the fruit. The tonka bean is also found scattered through the forest lands of Colombia.

HORSE-BREEDING IN ANDALUSIA.

Andalusia has always been famous for its fine horses, and Jerez de la Frontera, since the seventeenth century, has been perhaps its most noted centre for horse-breeding. The town itself was one of the first and last Moorish strongholds in Spain, and the best horses there were all bred from famous Arab stallions, so that what is known as an Andalusian or Spanish horse has always a good deal of Arab blood. It has, however, been crossed with so many other breeds, especially Flemish, that to-day the Spanish horse is not registered in the books of record of pure-bred animals, according to the American Consul at Jerez de la Frontera. The Spanish Government has altogether six zones or stations for breeding horses for the army, and maintains in each a "deposito semental," containing about eighty-five stallions, besides ten or twelve remount stations. At the deposito at Hospitalet, near Barcelona, only artillery horses are bred. There is also a Government "yeguada" (from "yegua," a mare), containing seven hundred mares, at a farm called Moralatta, in the Province of Cordova, and another is being formed. The "deposito semental" at Jerez, established by the Spanish Goverment forty years ago, in an abandoned Carthusian manastery, called the Cartaja, is the best, and that at Seville the next best in the zone of Andalusia, which is said to be the best zone in Spain. Horse-breeding is still carried on in Jerez, but in a much lesser degree; the demand, however, is always greater than the supply. The cause of the decadence in horse-breeding in Jerez generally is a lack of means, the increase in the use of agricultural machinery, and the fact that every year many stallions are purchased and sent to Central and South America. Portugal, too, does not breed horses, and every year buys about two thousand in Andalusia. A Jerez dealer in horses says that, although the Spanish horse has been somewhat superseded of late years for certain work by the half-bred Spanish-English hackney, yet its supremacy as a saddle-horse, not only for fleetness but endurance and strength, has frequently been demonstrated.

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On long and arduous journeys the only horses surviving the extreme hardships and lack of food have been the Spanish, the imported horses having succumbed. They undoubtedly are gifted with great endurance, and have a tenacity of life truly remarkable. It is stated that no matter what class of animal is brought to Andalusia, in two generations it acquires this remarkable toughness and endurance. This is said to be due partly to the climate, but principally to their feeding on a rich wild clover, called "zulla," found only in the Province of Cadiz, which people in that district say is the finest food in the world for horses. The zulla is very rich in sustenance, and grows to three or four feet in height, and with more luxuriance in chalky, clayey soil, such as is found in the vineyards which produce the famous Jerez wine or sherry. It is never sown or cultivated, as it seems to grow best wild. A large quantity, as much as forty tons to the hectare (2·47 acres), is sometimes gathered, and is cut and dried like hay.

RADIUM BATHS IN BOHEMIA.

The old town of St. Joachimstal, at an elevation of over two thousand feet in the ore mountains, about twenty miles north of Carlsbad, was once famous for its silver mines. As early as the year 1545 the National Government came into possession of the mines, and proceeded with the mintage of the original silver dollar, the so-called "Joachimsthaler." Long after the silver and copper mining activities of St. Joachimsthal had come to an end, other ores, such as bismuth, nickel, and, more particularly, uranium, were mined there. The last was used for colouring glass and porcelain, which are extensively manufactured in the vicinity of the old town. However, it is only since the discovery of radium that the St. Joachimstal uranium deposits have become famous. They are richer in this most precious element than any similar deposits in the world. The chief use of radium is for medicinal purposes, and, recognising this, the Austrian Government, several years ago, installed a provisional bath house near the mines. It was then demonstrated that the results of the radium treatment were most satisfactory in cases of gout, rheumatism of the joints, neuralgia, and similar diseases. The American Consul at Carlsbad states that, under the direction of the Austrian Ministry of Public Works, the building of a modern bath establishment was begun at the mines in the summer of 1910, and this was formally opened on October 22nd, 1911, in the presence of various high government officials. The building is equipped with the latest and most practical devices for the application of radium therapeutics. Although certain solutions of salts of radium are injected under the patient's skin, the principal method of application of the radium treatment is by the use of "emanations" from the element. The radio-activity, both of water and air, is utilised in these cures. The new bath establishment has numerous bath-rooms, where warmed radio-active water from the uranium mines is available in tubs, the exact degree of radio-activity necessary for every case being carefully regulated. Besides the emanation from the water through the skin, provision has been made for drinking the radio-active water, as well as inhaling radio-active air. The very latest scientific inventions are used to preserve the radio-activity of the waters. The medical director of the establishment has invented a flask, by means of which the St. Joachimstal waters can be shipped with a minimum loss of their radio-activity. Inasmuch as the building of the large and modern establishment at St. Joachimstal is expected to make the old town a "cure resort" of the first order, the next step, according to the Consul, will probably be the building of up-to-date hotels in the village. Eminent authorities have stated that the radio-activity of the St. Joachimstal waters is far greater than that of any other mineral spring, so it is not improbable that St. Joachimstal may become a notable addition to the already long list of celebrated Bohemian Spas.

CORRESPONDENCE.

THE SVASTIKA.

Having just read with great interest and admiration Sir George Birdwood's article on the svastika, it occurs to me that he deals out from his great stores of recondite learning with such a—I was going to say prodigal hand, but rather say *steam shovel—that it is really necessary to* "stand from under" in order to avoid accident. I have been hit on the head by a small lump which seems to consist of an extremely ancient name accidentally stuck to a very modern thing, where Sir George tells us the term "svastika" is applied to the revolution of the whole stellar cosmos about a centre bathetically called Hercules.

This motion is one of the most recent discoveries of astronomy, and could only be discovered since instruments could be made capable of measuring angles to one tenth of a second, say, within the lifetime of men now living. That men of this period in India, even if they had ever heard of this motion, should apply the name svastika to it seems a matter of very small importance, from which nothing of value could be inferred.

R. T. Mallet.

In reply to our member, Mr. Mallet, I regret that my article on the *svastika* did not make it plainer that it is not I, but the Hindus themselves, who have come to extend that ancient term to the modern European hypothesis of the sublime *pradakshana* of all the whole universe about a postulated "Hercules," or rather, I presume I should say, a postulated centre identified with Hercules. But this apart, the Hindus have always had a vague conception of the circulation of the

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total visible universe around a common centre in its Maker and Father.

I would take this opportunity to reply also to two private correspondents in the same connection. (1) I did not include right-handed passing round of the wine bottle, and dealing of cards, as instances of *pradakshana*, because that would have led me to go on, and at great length, into the question of the casting of omens by the Gods [by the right], and the receiving of them [by the right or left] by the Roman augurs; a profoundly interesting question, of which some time or other, some one can make another article. It simply shows that every one thing in this universe is every other thing; and that all at zero, or at 212°, are one and the same thing! (2) To the lady who blames me for including women among the items symbolised by the *suvastika*, my reply is similar to that given to Mr. Mallet,—that it is not of my doing, but of "the mild Hindu" symbolisers, who, all ladies should remember, are not of "the fair sex," but of the desperately unfair sex of "mankind"!

George Birdwood.

March 14th, 1912.

OBITUARY.

The Hon. Sir William Austin Zeal, K.C.M.G.—The death occurred on the 11th inst. of Sir William Austin Zeal, President of the Legislative Council of Victoria from 1892 to 1901, and a Senator of the Commonwealth Parliament from 1901 to 1907. Born in Wiltshire in 1830, he became a railway engineer in Melbourne. Developing a talent for public life, he was elected member for Castlemaine, Victoria, in 1864, and continued to sit in the Legislative Assembly till 1881, when he entered the Legislative Council. In 1892–3 he was Postmaster-General for the State, and in 1895 he was created K.C.M.G. He was a Director of the National Bank of Australia, of Messrs. Goldsbrough, Mort & Co., of the Melbourne Gas Company, and of the Australian Mutual Provident Society; a Trustee of the Melbourne Public Library, and a Territorial Magistrate for New South Wales, Queensland and Victoria. He joined the Royal Society of Arts in 1897.

John Samuel Phené, LL.D., F.S.A.—Dr. John Samuel Phené died on the 11th inst. in his ninetieth year. He was well known in Chelsea as a wealthy and eccentric old gentleman, and the owner of the "mystery house" at the corner of Oakley Street and Upper Cheyne Row. This is a high square building decorated in a most bizarre fashion, the front being covered with a jumble of twisting columns and quaint symbolic figures. He intended it to represent the Château Savigny in Central France, where his Huguenot ancestors lived. For many years he superintended the decoration, but a quarrel with the local authorities about an overhanging bit of work annoyed him, and the house was never completed. He was a great lover of trees, and is said to have been the first to suggest the planting of avenues in London streets. He served as Master of the Clothworkers' Company in 1906–7, and he was a Vice-President of the Royal Literary Society. He was elected a life member of the Royal Society of Arts in 1906, and he was also a Fellow of the Society of Antiquaries, and of the Royal Geographical and Geological Societies.

NOTES ON BOOKS.

Examination Work in Building Construction. By Henry Adams, M.Inst.C.E., M.I.Mech.E., late Professor of Engineering at the City of London College. Published by the Author, 60, Queen Victoria Street, E.C. 2*s*. 6*d*. net.

Professor Adams has collected together in this volume the examination questions and answers written by him and published at intervals in the *Journal of the Society of Architects*. The author has had great experience as examiner to the Board of Education, the Society of Architects, the Royal Sanitary Institute, and various other public bodies. He therefore knows precisely what an examiner expects from a candidate, and his answers are models of clear and concise statement, such as, unfortunately, too seldom meet the eye of the long-suffering examiner. The book contains a large number of diagrams, which have been necessarily reduced to about half the size required in the examinations.

Heat and the Principles of Thermodynamics. By Charles H. Draper, B.A., D.Sc. London: Blackie & Son, Ltd. 5*s*. net.

This is a new and revised edition of the text-book which originally appeared eighteen years ago. During that time, of course, very considerable advance has been made in the study of the subject, and the author has brought his work up to date by describing modern means of attaining and measuring very high and very low temperatures, and generally by extending the space devoted to thermometry and electrical methods. The first part of the work is experimental; the second, which deals with the principles of thermodynamics, is necessarily somewhat mathematical in nature. The book contains some specimen examination papers of the University of London and the Board of Education.

Meteorological Instruments and Weather Forecasts. By H. T. Davidge, B.Sc., M.I.E.E. London: Percival Marshall & Co. 6*d*. net.

This little pamphlet forms No. 16 in the well-known *Model Engineer* series—a series which is as excellent as it is unassuming. Mr. Davidge

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explains in simple language the principles of the various kinds of thermometer, barometer, anemometer, rain recorder, sunshine recorder and other instruments used by meteorologists, and he concludes with a chapter on weather forecasts, in which he shows the use of synoptic charts, and defines the meanings of such commonly used and commonly misunderstood terms as cyclones, anticyclones, V depressions, etc. The volume only contains some ninety small pages, but anyone who has read it—and it may be read intelligibly by a tyro—will have put himself in a fair way to understand the general principles of meteorology.

GENERAL NOTES.

Exmoor Sheep for Canada.—Professor Elliott, the Superintendent of the Canadian Pacific Railway demonstration farms in Southern Alberta, purchased during his recent visit to England a small flock of Exmoor sheep for breeding purposes from the well-known flock-masters, Messrs. Tapp & Smith, of Dulverton. Professor Elliott considers that these sheep will thrive well on the foothills of the Rocky Mountains, and the experiment will be watched with great interest. He was much struck also with the Devon cattle that he saw on Exmoor, and he may induce his company later on to acquire a picked herd. Alberta is an ideal country for mixed farming and dairying, and every effort to widen the present narrow basis of agriculture in the West, which rests too exclusively on wheat-growing, is to be commended.

Southern Persia and Economic Development.—The coastal belt of Southern Persia, which is anything from fifteen to sixty miles in breadth, is, wherever sufficiently fertile, given over to the cultivation of grain, but the rainfall is the principal factor governing the possibility of export each year. Across the mountains, however, a harvest can almost always be relied upon, and yet, though the amount produced is so far above the needs of the cultivators that a considerable amount is usually set fire to, high rates and dearth of animal transport make it impossible to get a pound of this to the coast for export. Besides grain, there are, says Mr. Vice-Consul Chick, in his report just issued (No. 4823, Annual Series), certain berries and wild nuts which would be of interest for vegetable oils, and other products, such as vegetable silk, awaiting the advent of European "discovery," for Persian traders are both unaware of possible commercial uses to which produce may be put, and, further, are never willing to try experiments. Unfortunately, little pioneer work or specialisation has been done so far by European firms settled in the country. The only exception is gum tragacanth, the purchase and sorting of which has become systematised to a certain extent in Shiraz. Almonds, raisins and sultanas, linseed, sesame, and Persian tombaku should all, in Mr. Chick's opinion, repay firms undertaking purchases on a large scale from the districts where each is cultivated. But all development of the internal trade, and of improved communication, is largely dependent on port improvements. None of the present outlets of trade along the Persian shore of the Gulf are satisfactory in their present condition.

Australian Precious Stones.—A great many precious stones are found in Australia. The gem most sought after is the Australian black opal, which is found nowhere else in the world. It appears in limited quantities in the matrix of ironstone and sandstone in the Lightning Ridge district of New South Wales. It is estimated that since 1890 opals valued at over £1,200,000 have been found in the State of New South Wales. Queensland also produces many opals, the production up to the present time amounting to about £200,000. Sapphires rank next among Australian gems in value of production. They are found in New South Wales and in Queensland, chiefly in the latter State in the gravel or creek beds. The gems show excellent fire and lustre, but the colour is a darker blue than the Oriental sapphire. In Queensland the present production amounts to about £15,000 annually, the total output to date being about £150,000. Other precious stones found in different parts of Australia include emeralds, turquoises, topaz, zircons, garnets, rubies, amethysts, tourmalines and beryls. Diamonds are found to a limited extent in New South Wales and in South Australia. Pearls are found along the northern coast of Australia. The quest for pearl shells is perhaps the most important industry of the northern part of Australia.

A New Siberian Exhibition.—Several exhibitions have been held in Siberia, the last in 1899 at Khabarofsk, on the Amur River. In order to call attention to the country's progress, and show the development of the Russian Far East since then, the local authorities have decided to hold another in 1913, which will also celebrate the three hundredth anniversary of the Romanoff reign in Russia. It will be held during August and September, as the Priamur Region Exhibition of 1913, at Khabarofsk, the capital of the Priamur district. Special buildings will be erected, and permits for space for exhibits will be granted on application. Gold, silver and bronze medals, as well as diplomas and money prizes, will be granted to exhibitors. Special attention will be given to agricultural implements and machinery for preparing the land, its fertilisation, planting, harvesting, thrashing and cleaning the grain, also to machinery for preparing food for cattle, and manufacturing agricultural products. In short, all phases of agriculture, gardening, apiculture, cattle and horse-breeding, etc., will receive consideration.

The Cultivation of the Poplar Tree in Italy.—During the last few years an active propaganda has been made by some of the

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principal paper-makers in Italy, to encourage the growing of the poplar in that country. This tree is very common in Piedmont and Lombardy, where it is planted on the banks of the numerous irrigation canals and the valleys of torrents and rivers. The wood is used for a variety of purposes, and especially for making packing-cases. The pulp of this wood is excellent for the manufacture of paper, being white, soft, and free from resinous substances. It is considered that by the afforestation of waste and unproductive lands, a good return for the capital expended might be obtained by the manufacture of pulp from poplar wood trees. A systematic cultivation of this tree, on the best lines of forestry practice, is strongly urged by many of the principal local agricultural societies. In consequence of the high price of wood-pulp in Italy, and in order to render themselves independent to some extent of foreign supply, a few of the leading firms have set an example by establishing their own plantations. The results of their experiments have been most satisfactory. In one case a return of 15 per cent. on the outlay is said to have been obtained. A leading firm of paper-makers, with works near Milan, a few years ago established important plantations of poplars in the valley of the Ticino, where, being subject to floods, and with a stony and gravelly soil, the land is of little value for agricultural purposes. Several thousand trees are planted here every year, and in the course of a few years these plantations, it is expected, will furnish an abundant supply of raw material for paper-making.

Apiculture in South Russia.—According to a report by the apiary committee of the Imperial Agricultural Society of Southern Russia, it appears that apiculture is a favourite occupation of small landowners and the working classes. These are assisted by the Government zemstvo organisations and some of the apiary societies having special funds for the purpose. Many of the zemstvo organisations in the south of Russia maintain warehouses of apicultural accessories, from which peasants beginning bee-keeping receive proper hives free of charge, one or two hives being given per head. In other cases they are sold at low prices on the instalment plan. The ordinary peasant can also obtain, for almost nothing, all literature at hand upon the subject of bee-culture, the poorest being supplied free of charge. Meeting the demand for them, the Government and zemstvo organisations have established schools of apiculture at Warsaw, St. Petersburg, Moscow, and elsewhere, and have introduced courses of apiculture in some of the agricultural schools for scholars and teachers in the public schools. The methods of teaching are well arranged as regards both the practical and the theoretical sides. The Government and zemstvo organisations maintain staffs of apicultural instructors, who are sent to various points to give instruction to those interested in the work, and to assist teachers already engaged in the few existing schools.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock :—

March 20.—F. Martin Duncan, "The Work of the Marine Biological Association." P. Chalmers Mitchell, D.Sc., LL.D., F.R.S., will preside.*

March 27.—Theodore E. Salvesen, "The Whaling Industry of To-day." Lord Sanderson, G.C.B., K.C.M.G., will preside.*

April 17. — John Henry Coste, F.I.C., "Municipal Chemistry." Dr. Rudolph Messel, F.R.S., will preside.

April 24.—George Fletcher, "Technical Education in Ireland."

May 1. — William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

May 8.—E. D. Morel, "British Rule in Nigeria."

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock :—

April 25.—Sir John O. Miller, K.C.S.I., "The Central Provinces."

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock :—

March 26.—Leonard Lovegrove, "British North Borneo." *

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Cantor Lectures.

Monday evenings, at 8 o'clock :—

Noel Heaton, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

Syllabus.

Lecture I.—March 18.—*The Development of Decorative Painting.*—Definition—Necessity for knowledge of materials—Origin of different methods—Development of distemper—Fresco—Encaustic—Tempera—The methods of the mediæval painters—Rise of oil painting—Growth of pictorial art and decline of decorative treatment—The loss of tradition as regards methods of working—Problems to be faced in modern work—Choice of a method.

* These papers will be illustrated by lantern views and by the cinematograph.

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LECTURE II.—MARCH 25.—*Fresco and its Modifications.*—The nature of plaster—Chemistry of fresco process—Practical details—Quality of the result—Limitations—Nature and selection of pigments—Problem of durability—Protection of surface—Modifications of the process—Fresco-secco — Stereochrome — Keim's process — Oxychloride process—Possibilities of development.

LECTURE III.—APRIL 1.—*Oil and Tempera Painting.* — Tempera: technical principles on which it depends—Nature and use of natural and artificial emulsions—Yolk of egg—Casein, etc.—Protection of the surface—The problem of varnishing. Oil painting: the technical principles on which it depends—Its scope and facilities—The question of durability—Limitations as regards ground—Modifications of oil painting—Use of wax—Spirit fresco—Resins and varnishes—Oil tempera.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Noel Heaton, "Materials and Methods of Decorative Painting." (Lecture I.)

Bibliographical, 20, Hanover-square, W., 5 p.m. Mr. R. B. McKerrow, "English Printers' and Publishers' Devices, 1557-1640."

Surveyors, 12, Great George-street, S.W., 7 p.m. (Junior Meeting.) Mr. A. J. Baker, "Styles of Architecture in Country Houses as they affect Market Values."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. W. H. Ward, "The Architecture of the French Renaissance."

Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Lieutenant-Colonel Mackinlay, "Some Lucan Problems."

TUESDAY, MARCH 19...Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. Percy Ashley, "The Financial Systems of Germany."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Papers by Mr. F. W. Goodenough and Mr. Justus Eck, "The Lighting of Printing Works and Offices."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. T. R. Holmes, "Ancient Britain." (Lecture II.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on Papers by 1. Messrs. A. B. McDonald and G. M. Taylor, "The Main Drainage of Glasgow." 2. W. C. Easton, "The Construction of the Glasgow Main-Drainage Works." 3. D. H. Morton, "Glasgow Main Drainage: The Mechanical Equipment of the Western Works and of the Kinning Park Pumping-Station."

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. Somerville Hastings, "Toadstools."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. A. R. Dugmore, "Lantern Exhibition of Studies of Wild Animals in Africa and North America." 2. Mr. E. W. Shann, "Observations on some Alcyonaria from Singapore, with a brief discussion on the Classification of the Family Nephthyidæ." 3. Mr. G. H. Kenrick, "A List of Moths of the Family Pyralidæ collected by Felix B. Pratt and Charles B. Pratt in Dutch New Guinea in 1909-10, with Descriptions of new Species." 4. Mr. T. H. Withers, "Some early Fossil Cirripedes of the Genus *Scalpellum.*"

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Dr. F. B. Vrooman, "British Columbia and her Imperial Outlook."

WEDNESDAY, MARCH 20..ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. Martin Duncan, "The Work of the Marine Biological Association."

Meteorological, 25, Great George-street, S.W., 7.30 p.m. Professor Otto Pettersson, "The Connection between Hydrographical and Meteorological Phenomena."

Microscopical, 20, Hanover-square, W., 8 p.m. Mr. F. Enock, "Fairy Flies and their Hosts."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel the Right Hon. Viscount Esher, "The Coordination of the Naval and Military Services."

THURSDAY, MARCH 21...Economics and Political Science, London School of, Clare-market, W.C., 3 p.m. Dr. J. H. Lewinski, "The Origin of Property and the Development of the Village Community." (Lecture I.)

Authors, Society of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m.

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Dr. I. Bolivar and Mr. C. Ferrière, "The Orthoptera-Phasmidæ of the Seychelles." 2. Professor A. Dendy, "Living Specimens of Phasmidæ." 3. Miss May Rathbone, "Phyllody of Carpels in *Trifolium repens.*" 4. Mr. J. A. Liddell, "On *Nitocrameira bdellurœ*, a New Genus of Parasitic Canthocamptidæ." 5. Mr. W. West and Professor G. S West, "On the Periodicity of the Phytoplankton of some British Lakes." 6. Mr. H. N. Dixon, "Plants from South Portugal."

Chemical, Burlington House, W., 8.30 p.m. Messrs. A. K. Macbeth and A. W. Stewart, "Iso-Erucic Acid."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. F. A. Dixey, "Seasonal Dimorphism in Butterflies." (Lecture I.)

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Discussion on "The Causes Preventing the More General Use of Electricity for Domestic Purposes," to be opened by Mr. S. Z. de Ferranti, President.

Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m. Annual General Meeting.

FRIDAY, MARCH 22...Royal Institution, Albemarle-street, W., 9 p.m. Professor D'Arcy W. Thompson, "The North Sea and its Fisheries."

North-East Coast Institute of Engineers and Shipbuilders, Newcastle-on-Tyne, 7.30 p.m. Annual General Meeting.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, MARCH 23....Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Molecular Physics." (Lecture V.)

Corrections.—Dr. F. W. Edridge-Green desires that the following corrections be made in the report of his remarks in the discussion on the paper on "Some Modern Problems of Illumination," published in the *Journal* of the 8th inst.:—On p. 459, col. 1, l. 41, for the word "methods" read "processes," and on p. 459, col. 2, l. 18, for the words "the whole of the series," read "the older theories."

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Journal of the Royal Society of Arts.

No. 3,096. VOL. LX.

FRIDAY, MARCH 22, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 25th, 8 p.m. (Cantor Lecture.) NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." (Lecture II.)

TUESDAY, MARCH 26th, 4.30 p.m. (Colonial Section.) LEONARD LOVEGROVE, "British North Borneo." EARL BRASSEY, G.C.B., will preside. The paper will be illustrated by lantern-slides and by the cinematograph.

WEDNESDAY, MARCH 27th, 8 p.m. (Ordinary Meeting.) THEODORE E. SALVESEN, "The Whaling Industry of To-day." LORD SANDERSON, G.C.B., K.C.M.G., will preside. The paper will be illustrated by lantern-slides and by the cinematograph.

Further details of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, March 14th; SIR THEODORE MORISON, K.C.I.E., in the chair. A paper by MR. E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, on "The Indian Census of 1911," was read by MR. J. D. ANDERSON, M.A., I.C.S. (retired).

The paper and discussion will be published in the next number of the *Journal.*

CANTOR LECTURE.

On Monday evening, March 18th, MR. NOEL HEATON, B.Sc., F.C.S., delivered the first lecture of his course on "Materials and Methods of Decorative Painting."

The lectures will be published in the *Journal* during the summer recess.

EXAMINATIONS.

The number of entries for the Society's Commercial Examinations, which commence on March 25th, is 36,381. This number is 743 less than last year, when there were 37,124 entries.

PROCEEDINGS OF THE SOCIETY.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 20th, 1912; P. CHALMERS MITCHELL, M.A., D.Sc., LL.D., F.R.S., Secretary of the Zoological Society of London, in the chair.

The following candidates were proposed for election as members of the Society:—

Beecroft, D., The Class Journal Co., 231-241, West 39th-street, New York City, U.S.A.

During, Claudius Dyonisius Hotobah, 15, Pulteney-street, Freetown, Sierra Leone, West Africa.

Hartley, Frank Reginald, 3, Esplanade-road, Scarborough, Yorks.

Jenner, Harry, 35, Auckland-road, Ilford, Essex.

Markel, Karl Emil, Ph.D., 20, Queen's Gate-terrace, S.W.

Renton, James Hall, J.P., Rowfold Grange, Billingshurst, Sussex.

Stockdale, William, Rosebank House, Stubbins, near Manchester.

Sutherland, William George, The Birches, Ashton-on-Mersey.

The following candidates were balloted for and duly elected members of the Society:—

Ainsworth, Herbert, P.O. Box 1553, Johannesburg, South Africa.

Andrews, Fred Henry, 3, Park-hill, Clapham, S.W.

Bishop, Albert E., 1, Metal Exchange Buildings, Whittington-avenue, E.C.

Dodge, Walter Phelps, The Reform Club, Pall Mall, S.W.

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Kothari, Jehengir H., K.I.H., Karachi, India.

Millard, V. C. H., M.A., Shrewsbury House, Ditton-hill, Surrey.

Welch, George Winston, Danville, Kentucky, U.S.A.

The Chairman introduced the lecturer for the evening, and in doing so commended to the meeting the subject which had been set down for discussion, namely, the work of the Marine Biological Association. That association dealt entirely with the life of the sea. He need scarcely remind the meeting that all the green vegetation of the earth, all the population of the land, of fresh waters, and of the air, had taken its origin from the sea. Even we ourselves, who stood at the head of terrestrial animals, bear written deeply on the character of our structure the marks of our aquatic origin; and we all, in the pre-natal stages of our life, passed through a phase which had no meaning or sense of any kind unless one looked at it as a legacy from our ancestors who lived in the sea. The mystery of the origin of life would have to be dredged up out of the sea, if it was going to be discovered anywhere. The study of the life of the sea, therefore, he regarded as one of the most interesting subjects which could possibly engage attention. And he thought the inhabitants of this country, an island country ringed round by the salt sea, had upon them a special duty to investigate everything which happened in the sea. It was not only a duty, but it ought to be a process very profitable to us, because, although the poet wrote of "the unvintagable sea," yet there was no doubt that the harvest of the sea was one of the most profitable of all our industries. It was about those matters that Mr. Martin Duncan would speak. It was scarcely necessary to remind the audience that Mr. Duncan was the son of a very distinguished naturalist, and that he was himself a very distinguished naturalist. Mr. Martin Duncan had devoted a great deal of time to the subject, and had been one of the pioneers in applying the art of photography to the study of natural history. He had had special opportunities of observing the work of the Marine Biological Association at Plymouth, and he would lay before the meeting some of the results of the investigations he had made.

The paper read was—

THE MARINE BIOLOGICAL ASSOCIATION, AND SOME ACCOUNT OF THE WORK IT HAS ACCOMPLISHED.

By F. Martin Duncan, F.R.M.S., F.R.P.S.

It would be impossible for me to describe within the time at my command to-night all the useful and important work which has been accomplished by the Marine Biological Association since its foundation. Therefore I propose briefly to outline the character of the association, to give some idea of the results obtained during the period that the association was engaged on the work of the International Fisheries Investigations, and some account of the scientific work that has been accomplished at Plymouth; and finally, by means of the lantern and cinematograph, to show you some of my own efforts in the application of photography to marine biological investigation.

The Marine Biological Association of the United Kingdom owes its existence to a combination of scientific men interested in the advancement of marine biology, and of others who are interested in the important sea fisheries, and the many problems connected therewith—a happy combination of Science and Industry for the advancement of our knowledge on these very important subjects. The aim of the association is to afford every opportunity, both for the biological investigation of marine plants and animals, and for investigations into the habits and conditions of the life of those marine fishes which form the "harvest of the sea," and of which our present knowledge is both incomplete and insufficient.

The association was founded and constituted at an influential meeting held on March 31st, 1884, at the Royal Society. Professor Huxley was its first president, and Sir E. Ray Lankester, who initiated the movement, acted as honorary secretary. Sir E. Ray Lankester is now our president, and has through all the years which have passed since that historic meeting in the rooms of the Royal Society, taken the keenest interest in the advancement and welfare of the association. The affairs of the association are conducted by a representative council, without any charge upon its funds, so that the whole of the subscriptions and donations received are devoted absolutely to the support of the laboratory, to the prosecution of researches by the aid of its appliances, and to the advancement of the association. The income of the association is derived partly from an annual grant from His Majesty's Government, partly from an annual grant made by the Worshipful Fishmongers' Company, and by the annual subscriptions of members, special donations, the rental of tables in the laboratory, and the sale of specimens.

The laboratory at Plymouth is a handsome stone building, standing on Citadel Hill, facing the historic Sound, and close to the famous Hoe. It was opened on June 30th, 1888, the building and fittings having cost some £12,000. Since that time, investigations, practical and scientific,

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have been constantly pursued. The permanent scientific staff of the association consists of a director of the laboratory, a naturalist in charge of fishery investigations, and an assistant to the director, principally occupied in the collection, identification and preservation of marine animals. The employment of additional naturalists to carry out fishery or biological investigations must necessarily depend upon the subscription of funds for that purpose by private individuals or public bodies.

In addition to the permanent scientific staff, scientific men from England and from abroad come to the laboratory at Plymouth to carry out their own independent researches, paying a small rent for the use of a working table and other appliances, and by their investigations have made valuable additions to zoological and botanical science.

The declared object of the founders of the Marine Biological Association was "to promote researches leading to the improvement of zoological and botanical science, and to an increase of our knowledge as regards the food, life-conditions, and habits of British food-fishes and molluscs"; and this double purpose of scientific investigation and of special fishery study has been strictly adhered to by the council in its management of the funds at its disposal.

The part performed by the association in the progress of biological science generally in this country is at least as important as its fishery branch, and it must be remembered that many of the purely scientific investigations carried out in the laboratory have very important indirect bearings upon the solution of practical fishery problems. Thus, repeated experiments upon the life-histories of invertebrate animals in captivity are gradually but surely revealing the proper conditions for the successful hatching and rearing of marine fishes. Practical investigations upon matters directly connected with sea-fishing are constantly in progress, and embrace a variety of subjects, including the reproduction and development of fishes, the determination of the character of the egg, larva, and young at all stages of growth, with experiments on the rearing of fishes in captivity, and on their rate of growth in confinement and in the sea. Observations have also been carried out on the relation between the distribution, seasonal migrations, and varying abundance of fishes, and the physical conditions of the sea; also upon the distribution of flat-fishes at different stages of their growth, upon their migrations, and the destruction of immature fish on particular grounds, or by particular method, of fishing.

Although the headquarters of the association are situated at Plymouth, the work carried out by its officers is national, and by no means local in character. Thus, elaborate investigations were made from 1892 to 1895 by the officers of the association, working from Grimsby and Lowestoft as centres, in regard to the destruction of immature fish in the North Sea; while in the summer of 1902 the association undertook the investigation for His Majesty's Government of the fishing-grounds in the southern part of the North Sea, and the study of the changes in the hydrographical conditions and plankton in the waters of the English Channel, and continued these important investigations until March, 1910, when the work was taken over by the Board of Agriculture and Fisheries. This work was part of a scheme of international fishery investigations which had been formulated and adopted by a conference consisting of representatives of the European Powers bordering the North Sea, and the international programme drawn up by them, in its entirety, covers a wide and important field of investigation, including a thorough physical and biological examination of the waters of the North Sea, the Northern Ocean, the English Channel, and the Baltic, together with a systematic examination of the principal fishing grounds, and a scientific study of all the biological problems bearing on sea-fisheries. The results obtained by the Marine Biological Association in the part it has taken in this work are of wide and far-reaching importance, and already a large proportion of the results obtained have been tabulated and issued in Reports presented to both Houses of Parliament.

Six years ago, on February 21st, 1906, Professor W. Garstang read a brilliant and most interesting paper before this Society upon some of the results that had been obtained by the association in connection with the International Fisheries Investigations (see Vol. LIV. page 401, *Journal of the Society of Arts*), and gave a general survey of the work in progress. It is, therefore, unnecessary for me to enter fully into the details of these important investigations carried out by, or under, the able supervision of Professor Garstang. The following brief reference to some of the methods employed and results obtained, may, I trust, be of sufficient interest to those who are not already familiar with the work, to induce them to read Professor Garstang's paper. I would draw attention first

to the experiments in the marking and liberation of flat-fish, especially plaice, which were carried out with the view of throwing some light on the migrations and rate of growth of these fish, as well as upon the intensity of fishing carried on in different areas. To most landsmen I suppose the idea of marking a fish and throwing it back again into the sea, with the prospect of its subsequent recapture, must appear a curious, if not a somewhat hopeless kind of experiment; the chances of the recapture of a marked fish from among the teeming creatures of the deep appearing superficially somewhat remote. However, the results clearly show that this is by no means the case. In all the marking experiments carried out under Professor Garstang's supervision, the labels used were based upon Dr. Petersen's model, with certain modifications, and consisted of a couple of small discs perforated in the centre, and connected by a small piece of silver wire passed through the holes. In the actual work of marking, the silver wire, with a small bone button at its lower extremity, is passed through the dorsal edge of the body of the fish on the lower or blind side, about halfway down, very carefully, so as not to cause injury, and is then connected on the upper or eyed side of the fish with an oval concave disc of thin brass. The disc bears on its concave side a letter—" E." for England—and a distinctive number stamped upon it. The convex side of the disc lies next the fish, the shape having been designed to prevent the edge of the disc from cutting into the flesh, or otherwise injuring the fish. This object has been fully attained, while the number on the disc remains perfectly legible, and the brass itself free from foreign growths, even after prolonged immersion in the sea. Only perfectly healthy, vigorous fish were marked, and these, as they were marked and measured, were returned to the deck tanks supplied with running water, and kept there until the entire series to be liberated had been dealt with, so as to provide a further opportunity of rejecting fish of impaired vitality.

To obtain tidings of the recapture of these marked fish it was absolutely necessary to gain the interest and co-operation of the fishermen, and with this end in view notices were posted up in the chief trawling ports, and other means taken to make owners, masters, and men acquainted with the nature of the work. In the notices posted up, English fishermen who caught marked fish were requested to take note of the place, depth, and date of capture, and to hand the fish, together with such particulars, to the local agent of the association, or to forward them direct to the laboratory. In return the fishermen received the following rewards:—For fish and label complete with information as to place and date of capture, 2*s.*; for label alone, with the same information, 1*s.*; for label without information, 6*d.* In the case of valuable fishes, the market price was paid in addition to the reward, and in every case the cost of postage or transit to the laboratory. This course not only enlisted the hearty co-operation of the fishermen, but aroused the sincere interest of these brave, hardworking men, so that again and again they have shown more desire to know when and where and at what size the particular fish recaptured by them were set free, than to receive their due reward.

That the chances are nowadays strongly in favour of the possibility of the recapture of marked fish may be realised when we learn that out of 1,463 plaice marked and liberated, 287, or 19 per cent., were recaptured within a year. That the larger-sized plaice are capable of making very extensive migrations in a comparatively short time the two following examples will serve as illustrations. In the first case, a marked plaice, 33 centimetres (13 inches) long, liberated on December 12th, 1903, on the Leman Ground, in the latitude of Lincolnshire, was recovered by a Hastings trawler off Winchelsea, in the English Channel, on March 23rd, 1904; the fish having travelled a minimum distance of 175 miles in a little over three months. The second fish, marked and liberated on August 12th, 1903, off the Lincolnshire coast, near Mabelthorpe, was recaptured in April, 1904, in St. Andrews Bay, having in eight months travelled a distance of 210 sea miles from the point of its liberation. The intensity of the commercial trawling in the North Sea was demonstrated in these marking experiments by the fact that out of 855 marked plaice above eight inches in length liberated outside territorial limits, the number recaptured within twelve months yielded a total of 21 per cent.; while experiments on the Dogger Bank in the spring of 1904 resulted in the recapture of more than 40 per cent. of plaice exceeding ten inches in length. How the evil results of over-trawling on the Dogger Bank might be successfully overcome by the transplanting of immature fish from the crowded inshore nurseries to the Dogger Bank, Professor Garstang fully described in his paper already mentioned.

There is one very important piece of work in connection with these International Fisheries

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Investigations, carried out for the Marine Biological Association by Dr. W. Wallace, to which I should like to draw special attention, and that is, Dr. Wallace's investigations on the age and growth-rate of plaice, as determined by the appearance of the otoliths, or ear-stones, of these fish. Within the ear of a fish are to be found the usual otolithic accumulations, either in the form of fine, mucus-connected, calcareous particles, as in the elasmobranchs (sharks and rays), or as massive solid concretions in the teleosts. In the cod and haddock, for instance, one of the otoliths is strikingly large.

The otoliths, or ear-stones, of the plaice show alternate white and dark rings; the white rings being formed in spring and early summer, the dark in late summer and autumn. In winter the growth of the otolith, as of the fish, is generally in abeyance, one white ring and one dark ring being added to the otolith each year. The otolithic method of determining the age of plaice was introduced by Reibisch in 1899, and the observations of Dr. W. Wallace in England, and of Johansen and other Continental workers, have fully established the value and reliability of this method. This is a matter of much importance in relation to practical fishery problems, since it not only enables a more accurate estimate to be made of the rate of growth of fishes in different regions, but may also throw light upon the effects produced by fishing operations. By this method the great difficulty formerly experienced, owing to the large plaice moving out into deeper water, of obtaining the true average length of the fish at any particular age, has been overcome, and it is now possible to determine what appears to be a sufficiently reliable estimate of the average rate of growth of the plaice in the region investigated.

Prior to the discovery of annual rings in the otoliths of the plaice, the only method of inferring the average rate of growth of fishes was the method of frequency-curves, often known as Dr. Petersen's method, dependent upon the measurement of given-sized groups, and founded on the well-known facts that plaice and other fishes spawn but once a year, and that the spawning season is strictly limited to a definite small period of the year. This has proved a most unsatisfactory and uncertain method, for, as Dr. Wallace points out, "it is impossible to tell whether two successive size-groups are of the same year of age or of two successive years (as the method assumes), or, finally, whether the interval between them is more than one year, since an intermediate year might, for one reason or another, be missing. Now the otolithic method gives us directly *the age of individual* fishes; and not only the average size of an age-group, which, in favourable circumstances (a sufficiently big collection), may be inferred from measurement alone, but also *the range of size*, which it is impossible to infer accurately from the measurements, since the amount of overlapping cannot be certainly calculated."

The otolithic method of determining the age of plaice of different sizes, and the growth-rate of these fishes in different parts of the North Sea and English Channel, is now firmly established as an ideal and accurate method. During the course of the investigations carried out by the association, the age of some 20,000 individual plaice has been determined by an examination of the otoliths, and in each case the length and sex of the fish and the position of its capture have been recorded. The detailed analysis of this great mass of material has, as might be expected, increased our knowledge of the life and habits of this valuable food-fish very considerably, but it is impossible for me in this paper, which is an attempt rather to bring before you a general survey of the work of the association than of one special branch, to deal at all fully with the matter. The results throw much interesting light upon the size and age of plaice at maturity in different regions. Thus it has been shown that in the central part of the North Sea, around the Dogger Bank, female plaice are on the average 40 centimetres (16 inches) long, and the majority just six years old, when they become mature for the first time; while male plaice average 32 centimetres (12½ inches) in length and five years of age, when they first reach maturity. In the southern bight of the North Sea, however, the females reach maturity a year earlier, measuring at first maturity about 33 centimetres (13 inches) in length, and the average age of five years. The average size of plaice at first maturity in the western part of the English Channel appears to be about the same as in the southern bight of the North Sea, but owing to the more rapid growth of the young plaice in the Devonshire bays the corresponding age is about a year less. To quote from the report: "These observations are of importance in showing that the regional differences as to size and age of plaice at first maturity are more extensive and numerous than has hitherto been recognised, and are of interest in connection with the

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hypothesis of the existence of two races of plaice, a northern and a southern one, in the North Sea." And to quote again: "Such investigations of the age of the plaice population on the fishing grounds are also capable of yielding evidence as to the migrations of plaice, and by means of a series of samples taken along a line proceeding radially from the coast of Holland to the deeper water of the central part of the North Sea, the migration of the small fish from shallow to deep water has been traced. The mass of each age-group was found to move seawards to the extent of several miles between May and September, plaice in their third year taking in September the position which had been occupied in May by those in their fourth year; those in their fourth year in September that of those in their fifth year in May, and so on for the higher ages."

The association's experiments as regards the vitality of trawl-caught plaice point unfortunately to a very high percentage of mortality among the unmarketably small fish. The investigations show that the otter-trawl injures the fish to a greater extent than the beam-trawl, and that fish from a long haul are much less likely to survive than those from a short haul. An hour was estimated as the shortest time likely to elapse between the arrival of the trawl on deck and the shovelling overboard of any small unmarketable fish, under ordinary commercial trawling methods, and in the case of hauls of the beam-trawl, although relatively fewer fish appear to be fatally injured, in only five out of sixteen experiments did so many as 50 per cent. of the small fish appear sufficiently healthy to be likely to survive after return to the sea. With a view to throwing further light on this very serious question of the large destruction of immature marketable fish, experiments have been carried on by enclosing various parts of both commercial otter- and beam-trawls in an outer bag of fine mesh, so as to ascertain what fishes escape through the meshes of the trawl-net. These experiments have shown that relatively few fish escape through the more open-meshed "square" and "batings," or forward portions of the trawl, the bulk of the fish making their escape after reaching the "cod-end," the fine-meshed terminal portion of the trawl-net. The experiments showed that the average sizes at which 75 per cent. of the fishes which reached the cod-end of the trawl were retained by the trawl were as follows:—Plaice, 12 cm. (4·7 inches); dab, 13·5 cm. (5·3 inches); cod, 17 cm. (6·7 inches); whiting, 19·9 cm. (7·8 inches); while 25 per cent. escaped through it.

Very valuable and interesting results have been obtained from experiments carried out under the association by Mr. R. A. Todd, B.Sc., with a view to obtaining information concerning the food of fishes, the contents of the stomachs of some 9,826 specimens of thirty-four species having been examined, classified, and reported on. The results so obtained show that in all fishes examined, and particularly in the case of the plaice, dab, and cod, the young, as compared with the older fish, show a marked preference for crustacea, chiefly consisting of amphipods, cumacea and decapod larvæ for food. An acute competition for food between various fishes probably exists in the case of a few species only, namely, in mollusca, *Solen ensis* and *S. siliqua* (between plaice, dabs and haddock), *Tellina fabula* (between plaice and haddock); in crustacea, *Crangon Allmanni* (between whiting, cod and grey gurnard), *Eupagurus Bernhardus* (between dabs, whiting and cod), etc., etc. It was also shown that a cessation of feeding during the winter months is apparent in the plaice, a habit which may be due to the spawning period of the fish, the number of empty stomachs observed during the winter months being 99 per cent. for November, 72 per cent. for December, 76 per cent. for January, and 57 per cent. for February; while during the remaining months of the year, from March to October, the percentage of empty stomachs in each month never rose above 7 per cent. It is impossible for me to enter deeply into the many interesting points raised by Mr. Todd's reports here, and therefore I can only briefly refer to some of the facts he obtained concerning the chief characteristics of the food of some of the species of fishes examined. Mr. Todd found that the grey gurnard (*Trigla gurnardus*) feeds almost wholly on crustacea, while the latchet gurnard (*T. lairundo*) feeds chiefly on pisces, *Solea lutea* and *Callionymus lyra* being the principal representatives. The angler (*Lophius piscatorius*) is a veritable glutton, one 99 cm. long being found to contain two cod of 45 and 50 cm., three haddock of 21, 22, and 30 cm., and other fish remains.

The cod (*Gadus morrhua*), when quite small ($<$ 15 cm.), feeds wholly on crustacea, chiefly amphipods, but feeds on other food-groups, especially pisces, mollusca, and polychæts, as it increases in size. The haddock (*Gadus æglefinus*) feeds chiefly on mollusca, polychæta, echinoderma, and crustacea, and when young

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undoubtedly does an enormous amount of damage among small mollusca, no fewer than 509 *Solen* fry of less than 2 mm. length having been counted in one stomach.

As the food of the very large plaice (50 cm. +) consists almost exclusively of mollusca (species of *Solen* and *Mactra*), it is obvious that the presence or absence of large numbers of small haddock will affect the food supply on the feeding-ground, and the number of the larger-sized plaice present. When small (< 10 cm.), the plaice feed chiefly on crustacea (amphipods, etc.) and polychæta. The whiting (*Gadus merlangus*) feeds chiefly on crustacea and pisces; the pout (*G. luseus*) on crustacea, pisces and mollusca; and the ling (*Molva vulgaris*) and turbot (*Rhombus maximus*) entirely on pisces. Soles (*Solea vulgaris*) feed chiefly on polychæta and crustacea, with some pisces and mollusca.

Leaving this interesting international fishery work, we will now consider some of the other investigations that have been accomplished through the Marine Biological Association, investigations which it is not too much to say have been only made possible by the existence of the association's laboratory at Plymouth. Among these investigations, Mr. J. Stewart Thomson's work on the structure and seasonal growth of gadoid and pleuronectoid scales calls for special mention, as bearing on both the scientific and commercial aspects of marine biology. This was a successful attempt on the part of Mr. Stewart Thomson to extend to certain marine fishes a system of age determination by means of the appearance of annual rings on the scales, a system which had already been shown by Dr. Hoffbauer as a reliable means of demonstrating the age of the carp.*

Mr. Thomson's investigations show that scale growth is accelerated during the warmer season of the year, but diminished during the colder season in such a methodic manner as to cause the formation of annual rings. The formation of these annual rings results from the fact that the lines of growth on the scale surface are comparatively widely separated from one another in that portion of the scale formed during the warmer season of the year, but are much less widely separated in that part built up during the colder season. Thus, by following the arrangement of the lines of growth upon certain scales, it is a simple matter to observe the starting-place of any year's growth by the comparatively wide separation of the growth-lines at that portion of the scale, and in this way the surfaces of scales appear mapped out by annual rings. These rings, therefore, supply us with an index as to the age of a fish, and may be roughly compared to the annual rings seen in many trees; while their divergence in growth during the summer and winter is probably due to the effect which seasonal variation of temperature, and more particularly of food supply, has upon the general growth of the fish. Mr. Stewart Thomson's results have been arrived at after the examination of thousands of gadoid scales, and he considers that from an examination of three or four well-developed scales taken from the median region of the flanks near the lateral line, it would be possible to arrive at a very close approximation of the exact age of the fish in ninety-eight cases out of a hundred. The truth of his hypothesis is fully supported by the work of Mr. Cunningham and Dr. Fulton.

Thanks to the systematic dredgings conducted by the association, fair samples of the bottom-deposits, including sands, gravels, pebbles, and small boulders, have been obtained, and have added considerably to our knowledge of the geology of the English Channel; and this subject has been dealt with in an important paper by R. Hansford Worth, published in the Journal of the association.

The experiments of Dr. E. J. Allen and Mr. E. W. Nelson, on the artificial culture of marine plankton organisms, have been crowned with success, and offer an example of pure scientific investigation carried out for the association, which at the same time has important value commercially; adding greatly to our knowledge of the possibilities and successful methods of rearing not only those diatomaceæ peculiar to the plankton, but of the larval-invertebrate and vertebrate forms of life which feed on them, and in turn constitute a large proportion of the food of the marketable marine fishes at certain stages of their lives. As a result of their experiments, Dr. Allen and Mr. Nelson have succeeded in rearing persistent cultures of some eighteen species of plankton diatoms; and their work on this subject has been published in detail in the Journal of the association (New Series, Vol. VIII. No. 5, p. 421–474). One of the greatest charms of marine biology is the way in which each piece of accomplished work opens up new vistas of possible and fascinating investigation. This, I think, I can demonstrate to you by briefly drawing attention to Dr. Allen's paper on "Mackerel and Sunshine," published in

* "Die Altersbestimmung des Karpfen an seiner Schuppe," von Dr. Hoffbauer; *Jahresbericht des Fischerei-Vereins für das Jahr* 1899.

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Vol. VIII. No. 4, of the Association's Journal. A paper in the same volume of the Journal (Vol. VIII. p. 269), on "Plankton Studies in Relation to the Western Mackerel Fishery," by G. E. Bullen, showed that in the years 1903–1907 there appeared to be a correlation between the number of mackerel taken during May and the amount of copepod plankton, upon which the mackerel feed, taken in the neighbourhood of the mackerel fishing grounds during the same month. From these results, Dr. Allen considered that "it was clearly worth while to consider what conditions favour the production of an abundant supply of copepods in the fishing area, since it appears to be this supply of food which attracts the mackerel into that area, or at any rate into its surface waters." Now it is pretty well established that copepods feed chiefly upon the vegetable organisms of the plankton, while even supposing a considerable proportion of their food were to consist of minute animal organisms, it is obvious that these in their turn would feed upon the phytoplankton. Therefore, to quote Dr. Allen's paper, "it is to the conditions which favour the production of phytoplankton, the fundamental food supply, that we must turn" for enlightenment. "The hydrographical investigations carried out at the mouth of the English Channel have rendered it probable that the movement of the water there is comparatively slow. It may, therefore, be assumed that on the mackerel grounds to the westward of the Cornish coast the water which is present at any particular time has not recently moved into the district from any very remote region, and, treating the matter broadly, has been subjected for some time to the general climatic conditions of the neighbourhood. The question then suggests itself, can the differences which occur from year to year in the abundance of the copepods be referred in any way to such climatic conditions?" After pointing out that the three most obvious matters to be considered in connection with the production of the vegetable plankton are the composition of the sea-water, the temperature, and the amount of light available for the production of plant life; that the only information available concerning the composition of the sea-water refers to its salinity; and that up to the present it has not been possible to show any simple relation between changes in salinity and changes in the animal or vegetable production in the area under consideration, Dr. Allen writes as follows: "Experiments on the cultivation of marine plankton diatoms in the laboratory, upon which I had been engaged, had drawn my attention to the great importance to be attached to the intensity of the light to which the diatoms were exposed. It therefore occurred to me that a special abundance of copepods during the month of May in any year might be due to a special amount of sunshine during the earlier months of the year, which would increase the amount of phytoplankton, the copepod food." The results of Dr. Allen's investigations are fully described in his paper from which I have quoted above, and seem clearly to indicate that a fundamental correlation exists between the abundance of mackerel in May and the amount of bright sunshine during the earlier parts of the year. Indeed, when plotted out, the extreme closeness of agreement between the sunshine curve and the mackerel capture curve is most striking. Mr. A. E. Hefford's observations on teleostean ova and larva is another valuable piece of work successfully accomplished, thanks to the existence of the laboratory at Plymouth; while mention must also be made of Professor J. T. Cunningham's valuable works on "The Natural History of the Marketable Marine Fishes of the British Islands," and his "Treatise on the Common Sole," the former prepared by order of the council of the Marine Biological Association.

Other important work carried out at Plymouth by Dr. Allen has been the investigation of the fauna and bottom-deposits near the thirty-fathom line from the Eddystone Grounds to Start Point; and, in conjunction with Mr. R. A. Todd, of the fauna of the Salcombe and Exe estuaries. The existence of the association's laboratory has enabled investigations to be carried out on the reproduction of fishes, and the life-history and habits of a vast number of marine organisms. Of researches carried out under the auspices of the Marine Biological Association in the Laboratory at Plymouth, or on the North Sea coast from 1886 to 1907, the number published in different scientific journals reached the respectable total of 415.

Such is a brief survey of the history and work of the Marine Biological Association, but I hope that while the time at my disposal has made it impossible for me to do more than lightly touch upon the subject, necessarily leaving many interesting points unmentioned, this outline-sketch which I have had the honour of presenting to you to-night will have illustrated the really vitally important work which the association has accomplished, and the pressing need for the wider support of this institution, that it may in the future be better able to continue and successfully carry out those investigations which

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are of such importance not only to science, but also to the general community. Under the present conditions the income of the association is never quite sufficient to cover its expenditure on research, and from year to year continuous investigation of both biological and fishery problems has to be scamped, if not brought to an abrupt stop, owing to lack of funds. In the Marine Biological Association of the United Kingdom, equipped as it is for research that will reveal to us the solution of innumerable problems connected with those important fishing industries which constitute the "harvest of the sea," and one of our most important sources of food supply, and will give the answer to many of the enigmas of biology, we have an institution deserving the strongest financial support. Our neighbours across the Channel and our cousins across the Atlantic are ever ready to mock at British apathy towards the advancement of science; and it certainly does seem an extraordinary state of things that we, who pride ourselves on being the greatest maritime nation the world has ever known, do not possess in our capital city of London an oceanographical institute. That is bad enough; but let not our foreign rivals point the finger of scorn at us and say that we cannot even support our Marine Biological Association adequately to carry on its useful and important work.

And now, if you will permit me, I will show you a few of the latest results which I have obtained in the course of my studies of marine animal life, and my application of photography as a means of keeping a graphic record of my biological work. It is rather more than twenty years since, as a student, I first took up photography as a means of keeping a record of microscopical and biological research—chiefly, in those days, with the view of helping my dear father, the late Dr. P. Martin Duncan, F.R.S., in his investigations on the corals and echinoderms. Since then I have had my cameras in almost daily use for the various branches of scientific work in which I have been engaged, so that I am in a position fully to appreciate the very great value of photography as an aid to scientific investigation. The movements of animals have always deeply interested me, and prior to the introduction of celluloid bands, which made the cinematograph an accomplished fact, I began taking serial photographs somewhat on the lines of Professor Marey, using a home-made apparatus, and mounting the results on a kind of zoetrope or "wheel of life"; but with the first introduction of the cinematograph the old apparatus was abandoned. Of the cinematograph results which I am now going to show you, I would particularly draw your attention to those of marine worms, because you will see how very characteristic are the movements of each species represented, and also because it was at the suggestion of Sir E. Ray Lankester that I attempted to obtain them. I am also going to show you the movements of certain marine fishes, crustacea, echinoderms, and molluscs.

DISCUSSION.

The Chairman called attention to the extent to which the various creatures inhabiting the sea had interactions upon each other, and how, accordingly, the life of the sea, or any part of it, must be studied with that fact in mind, and how that was necessary in order to arrive at any real and adequate understanding about it. As the lecture proceeded, it became more and more impressed upon him how futile it was to try to single out any one particular phase of the subject, such as that which concerned the practical aspect regarding food fishes, without considering the matter as a whole. One could not proceed far in a study of the life of food fishes without including in one's purview the whole sea community. The relationship of mackerel to sunshine was a remarkable case in point. Nor could one successfully study the life of one particular part, such as the North Sea, without at the same time making hydrographical investigations into the quality of the water in the Arctic and Atlantic Oceans, because of the slow, intermittent seasonal changes, and the current movements, the bulk of the water sometimes coming from one region, sometimes from another. Amongst the recent work which had been done, he thought the most interesting, and that which was the most profoundly promising, was what Mr. Duncan had not had time to say much about, namely, the work of Dr. Allen in making what were known as "pure cultures" of the microbes which lived in sea water. It was known by the audience, of course, that just as the green vegetation on the land was the ultimate source of all the food supply of the land—a certain number of animals lived on green plants, and other animals lived on these animals, and, however it was traced, the ultimate source of the food was the green plant—so also the ultimate source of all the food upon which fishes lived was the green vegetation, the small things floating on the surface of the sea. And Dr. Allen's investigations into the conditions under which the separate organisms of the sea lived seemed to him to be of the greatest possible promise, not merely towards an understanding of the practical problem of increasing sea fishing, but possibly for increasing the actual bulk of food in the sea, and accelerating the growth of marketable fish. No isolated study was likely to advance the science of marine biology,

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either practically or theoretically; this object could only be properly attained at a properly-equipped institution containing specialists in the different departments of biology who were working together towards the same end.

Mr. Frank Farnell (late Chairman of the Board of Fisheries, New South Wales) said it had been an intellectual treat to him to listen to the paper and see the slides and cinematograph demonstrations. He had been associated with fisheries in the Australian colonies for a number of years, and though he was not a student of the same character as Mr. Duncan, he recognised the great value of scientific investigation in regard to fisheries generally. Some time ago, when an attempt was made to put trawling on a proper basis in Great Britain, objections were raised by practical fishermen to the proposal, and one reason for the objection was that the process tended to destroy the ova of the fish. But scientific investigation showed that trawling had no effect on the spawn of the fish, because in the case of the majority of the fish in our own waters the spawn was pelagic. So in that one instance, if attention had been paid to the practical experience of fishermen at that time, the great industry of trawling would have had a set-back. The work of scientific men such as Mr. Duncan succeeded in dispelling many clouds of ignorance on the subject. One of the points set out by the lecturer had convinced him of the solution of one of the problems which faced those interested in the matter in New South Wales. They were there anxious to engage in the introduction or acclimatisation of certain species of fish; and for that purpose some kinds were introduced from English waters. They lived in the Australian waters at a temperature of over 70°, though it was anticipated that with anything over 40° they would succumb. But he regretted to say that in inaugurating that experiment, adequate provision was not made by the authorities for the treatment of those fish when they arrived there, and owing to the absence of that provision the fish practically all succumbed. But in the last few years flounders had been introduced from Tasmania. His contention had always been that it might be all very well to engage in introducing new species of fish, but if it was at all possible, those fish thus introduced would probably find their way back to the region from which they were originally brought. The fish which were introduced from Tasmania in the gravid state, after hatching their ova at the marine biological station there, were found 100 miles lower down than Sydney. That seemed to be the extent of the region of their distribution from Tasmania. They had not only been liberating the adult flounders after collecting the spawn from them, but had liberated hundreds of millions in the "fry" stage; and there had not been any instance in the last seven or eight years showing that those fishes, either adult or fry, had remained in the regions of the Sydney waters. These experiments were of very great value in proving to the world what were the migratory habits of the different fish. His belief was, in connection with the introduction of the Tasmanian flounder to New South Wales waters, that directly they got free they returned to the district to which they properly belonged. In conclusion, he desired to express his keen appreciation of the paper, which would prove of great interest and value to the Fisheries Board of New South Wales.

The Chairman formally moved a vote of thanks to Mr. Martin Duncan for his extremely valuable paper, and the beautiful illustrations. It was unnecessary to comment upon them; they constituted their own justification.

The vote was unanimously carried.

Mr. Duncan, in acknowledging the vote, said that if he had succeeded in awakening a keener interest in the Marine Biological Association and its valuable work, he would feel that his efforts had been amply rewarded.

EMPIRE NOTES.

Chambers of Commerce of the Empire.—The proposed Congress of British Chambers of Commerce, which is to be held in London in June, will be an important gathering. The arrangements for it are being made by the British Imperial Council of Commerce, which was formed in June last, and on which the leading Chambers of Commerce of the Empire are represented. Over 500 delegates are expected to attend from all parts of the Empire. The main object of the meeting will be "to focus the views of the whole of the Chambers of Commerce of the Empire on matters of common interest, and to get public opinion to bear upon Governments in favour of various matters and reforms which the business men of the Empire consider necessary to its material prosperity and development." Among the subjects to be considered will be Penny Postage throughout the Empire; the "All-British" cable; the question of double income tax on investments at home and in the Dominions; commercial arbitration; preferential trade; national defence; emigration, and the Panama Canal. The last-named subject is one of special importance, as the conditions under which that waterway between the Atlantic and Pacific Oceans may be used will have an important bearing upon the commercial intercourse of the Empire.

Transatlantic Mail Service.—The mail contract, entered into by the Canadian Government in 1906, expires on May 1st of this year. Rumours are afoot regarding the terms upon which the new contract will be made. The late Dominion Government were in favour of the abolition of a direct subsidy during the summer months, and many of the leading steamship lines, finding that it pays to run fast vessels between the Mother Land and

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Canadian ports, would be willing to carry the mails, on a payment equal to a slightly advanced freight rate. The new Government, however, is making an attempt to bring about the much-talked-of "all-red route" service, an initial step in the direction of which would involve the subsidising of steamers, as fast as, if not faster than, those now running. An adequate subsidy for this purpose would cost the Dominion Government at least £800,000 per annum, instead of £120,000 as at present. It has been suggested that, in order to secure the adoption of this desirable service, the Home Government should join in the subsidy, but the likelihood of their doing so is extremely remote. It is argued that with the existing rate paid to the shipping companies, it would be impossible to get capitalists to interest themselves in providing an accelerated service. Whatever may be the outcome of the new proposals, it is certain that the present Canadian service is in need of numerous improvements. There is, surely, no reason why Canada should not have as effective a mail service as that which exists between Great Britain and the United States.

Canadian Contracts for British Firms.—Two large contracts have been recently given to British contractors, the value of one being £1,500,000 sterling, and the other is also over a million. This fact is of some interest, in view of the growing tendency to suggest that British tenderers are unduly handicapped in competing with local organisations. An English trade journal has been vigorously attacking the system of contract awards, asserting that there is a lamentable lack of fairness. Something is known in this country of local influences and prejudices in the element of contracts, and it is not to be expected that the same element will not appear in Canada. Owing, however, to the lack of skilled labour and the high wages paid in the Dominion, British contractors have a better chance of securing many of the large contracts than the Canadian firms themselves. Up to the present, the chief rival of Britain has been the United States, where a careful study of Canadian opportunities has been made. Hitherto, several wealthy British engineering firms have allowed many excellent opportunities to pass. It is to be hoped, however, that in future, greater attention will be paid to the opportunities offered to British manufacturers by the rapid development and increasing requirements of Canadian trade.

The Prosperity of Newfoundland.—At the opening of the Legislature of Newfoundland last month, the Governor congratulated the Colony on its unexampled prosperity. Every effort has been made during the present administration to improve the fisheries, roads and steamship services, and steps have been taken to enlarge the old age pension scheme for ameliorating the condition of the people. The Premier reports that there was a handsome surplus for the last fiscal year. With this surplus the Colonial Treasurer hopes to make greater strides to combat tuberculosis by the establishment of further and better equipped sanatoria. One of these institutions is located in St. John's, and there are sixteen others in various parts of the Island. These sanatoria are the gift of the Reid Newfoundland Company, and are maintained out of the public purse. Good fisheries, high prices of exports, all-round progress in mining, farming and manufacturing industries, were indicated as the factors in bringing about a state of affairs which is altogether satisfactory.

The Design for the Federal Capital.—A difficulty has arisen in securing designs for the new Australian capital, owing to the conditions imposed by the Government in relation to the competition. These require that the plans go before a committee of one engineer, one architect, and one surveyor, whose names, however, are not given, and who therefore, in the judgment of the Architectural Institutions of Australia, Europe, and America, might mean anybody. It has been suggested that a board should be appointed, consisting of three architects, one each for the British, United States, and Australian Institutes, to act, with engineers and surveyors, as judges. It is argued that an architect who competed would be put to great trouble and expense in preparing his design, and that he would require to be assured that those who are entrusted with the duty of dealing with the matter were competent for the work. Owing to the practical boycott of the leading architects of the above countries, only twenty designs have thus far been received. To meet the difficulty the Australian Minister for Home Affairs is arranging for a consultation between the Institutes, which, it is hoped, will lead to a revision of the conditions, and so enable a larger number of leading architects to compete.

Australian Fruit Industries.—The Government of New South Wales propose to establish fruit-canning, vegetable-canning, and jam-making factories in the Burrinjuck irrigation area on the Murrumbidgee. At these factories the produce of the settler will be handled at moderate rates and, subsequently, the factories may be taken over by the settlers themselves, under a co-operative arrangement. The experiment will be carried on by the Department of Agriculture. The fruit-growers will be encouraged to plant only the best varieties of fruit, and will be taught how to specialise in those varieties that are most useful for canning purposes. The Burrinjuck scheme of irrigation will bring under intensive cultivation no less than 350,000 acres of splendid land. It is stated that 500 irrigation farms in this area will be available for settlement in April. A similar proposal is under consideration in Victoria, in the well-known and fertile Bacchus Marsh irrigation district. The Commissioner is endeavouring to induce landowners in that district to sub-divide their properties for intensive cultivation, and

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suggests that a canning department be added to one of the district butter factories, for preserving the fruit raised by the settlers.

The Expansion of Trade in New South Wales.—The figures regarding the growth of manufactures and trade in New South Wales indicate that the year 1911 has shown a considerable advance upon former years. At the end of 1911, the number of factories was 4,823. Over 99,000 hands were employed, and goods valued at nearly £50,000,000 were manufactured. The value of the production, being the value added to raw materials, exceeded £17,000,000, an increase of £2,300,000 in the year. Increases are shown in almost every commodity. The butter produced amounted to 76,624,830 lbs. The New South Wales Government railways carried nearly 34,000,000 passengers during the half-year just ended, and 5,500,000 tons of merchandise. The net earnings of the railways for the period mentioned were £1,185,472, while the gross revenue reached £3,259,139. The State has 3,807 miles of railways open to traffic. The tramway system of New South Wales at the end of December last had 191½ miles open for traffic, and the gross revenue was £752,056. The net earnings were £113,503. The number of passengers carried was 127,336,793. The growth of railways and railway traffic is one of the surest signs of a country's increasing development, and the railway returns are satisfactory in every way. At the commencement of this year the shortage of labour was acutely felt, and at the moment the demand for skilled artisans in Sydney and other towns is pressing. To supply this lack, efforts are being made to obtain men from the United Kingdom, but owing to the want of adequate shipping accommodation there is no immediate prospect of the need being supplied.

Irrigation in South Africa.—This subject was dealt with in a paper by Mr. W. A. Legg, which appeared in the *Journal* of February 9th, and reference was also made to it in these columns last month. Information is to hand that a successful experiment, in the direction of transforming the arid Karoo into fertile farming land by means of irrigation, has been conducted at Hanover, where a stretch of level ground, comprising many acres, was ploughed and sown at the beginning of the season, an arm of the Seacow River, running through the district, having been diverted so as to flood the area. No less than 40,000 bundles of wheat and other cereals were harvested, as a result of the experiment. Following up this experiment, the Union Government has privately purchased several thousands of acres of land south of the Aughrabis Falls, on the Orange River, and also land on the north of the Falls, at a total cost of £15,000. At the moment nothing definite is known as to the purpose which prompted this action, but the general impression is that the ground will be used for irrigation purposes.

Asiatic Trading Licences in Rhodesia.—Throughout South Africa, British traders have been attempting, for many years, to eliminate the small trading operations of the Asiatics. The first great blow to these natives of India and China was the Eight Hours' Shop Act. This Act had the effect of putting half the Asiatic trading population out of employment, and ended in their return, in large numbers, to their native countries. Since that time it has become law that no coloured man can trade without a licence. An interesting case recently occurred at Buluwayo, where the town council refused to grant a trading licence to a certain Asiatic. Sir William Milton, the Administrator, reversed the decision, and a considerable amount of unfavourable comment was consequently called forth. Feeling is exceptionally strong throughout Rhodesia upon the question of licences, as it is held that the trading methods of Asiatics conflict with the popular sense of what is good for the community. The Buluwayo town council recently issued a warning to householders against the dangers of consuming commodities purchased from Indians without taking precautionary measures, and it was further suggested that the time had arrived for the total abolition of hawking. It is likely that an amendment of the law in this direction will be made.

CORRESPONDENCE.

THE SVASTIKA.

May I make amends to Sir George Birdwood for my levity by offering two other instances of the universal right-handedness, not mentioned by him? There lies before me a photograph by that learned photographer Mr. R. Welch, of Belfast, of the Cloca Breaca altar and "cursing stones" at Inishmurry, Sligo, Ireland. Mr. Welch told me the peasants used these to curse their enemies by walking round the altar contra-clockwise and turning each of the cursing stones on it, also left-handedly, while repeating the Pater Noster backwards. This requires great care, as any mistake would recoil disastrously on the curser. The largest of these stones, on the left-hand near corner, is inscribed with marks which, so far as appears from this one point of view, may well be a left-handed *svastika* and the signs of the zodiac.

The other instance is the universal use of right-handed screws, save in the rare cases where a special reason requires them to be left-handed.

R. T. Mallet.

Perhaps some of your readers may be interested in knowing that in reverence for the *svastika* the Chinese are not behind their Western neighbours. And possibly some of the Sinological members of the Society may give us fuller information on the use of the *svastika* in the extreme Orient. I

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remember reading somewhere that its employment as an ornament, either in metal or on embroidery, is one of the deadly sins, ranking with murder in wickedness.

W. H. SHOCKLEY.

NOTES ON BOOKS.

GOVERNMENT OF FORMOSA. Report on the Control of the Aborigines in Formosa. Bureau of Aboriginal Affairs. Taihoku, Formosa.

To all who appreciate the present powerful position of Japan between the Old World and the New, I would say—read this book. There are but forty-two pages of it; but the subject of them, and the way in which it is treated, and in which it is further illustrated by no less than one hundred photographs, and three maps, and three diagrams, and four statistical tables; and the paper, printing, binding, and general "forwarding" of the book, to the very monogram on its titlepage, are a prophecy of assured fulfilment—for all habituated to the handling of official administration reports—that, astonishing as is the greatness of Japan in the present—from the fateful February 8th, 1904—it will be found yet more marvellous and momentous in the future—and so long as it is justified and reinforced by righteousness and truth.

The Island of Formosa, perhaps first generally known to Europeans through the impostor George Psalmanazar's forged "History of Formosa," 1704, is about 225 miles in length, and 90 miles in breadth at its broadest, its whole eastern side being mountainous and virgin forest, from its prolonged southern extremity to within twenty miles of its rounded northern end; and draining off all its considerable streams through its western side into the sea; out of which the island rises in a series of terraces to the mountains, giving to the island its Chinese name of Tai-wan, *i.e.* "Terraced-beach." This western coast was partially settled by the earlier Spanish and Dutch adventurers into the Yellow Sea; but they were all expelled from it in the latter half of the seventeenth century by the Chinese, who, extending themselves through the lowlands, drove the aborigines back into their highland strongholds. The island was ceded to Japan in 1894; and the present Report deals with the control of these aborigines from that date to November, 1909. They occupy the whole mountainous eastern side of the island, from within seven miles of South Cape to within ten miles of Taihoku, the Japanese capital, situated about ten miles from the sea, on the north, where the semi-civilised lowland portion of the island extends continuously, with a breadth of about twenty miles, for thirty-five miles down its eastern side. The area of Formosa is in this way almost equally divided lengthwise, between its semi-civilised and its still more or less untamed autochthonous inhabitants. The latter population numbers 121,981 souls, in 683 villages: of which total the Ami, scattered over an average breadth of twelve miles, and a length of eighty-five miles, down the steep eastern coast, number 31,578, centred in 108 villages; and the Tai-yal, occupying nearly the whole northern half of these alpine wilds, 28,242, in 242 villages. The only other great tribes of the nine tribes named, are the Bunun, west of the Ami and south of the Tai-yal, counting 15,807 in 100 villages, and the Tsarisen, west of the Bunun, 13,995 in fifty-five villages. The Tai-yal are absolute savages; the Bunun and the Tsarisen are but little better; but the rest are gradually becoming more peaceful in their ways and means of life, and though they still hunt and fish they are also steadily taking more and more to agriculture and cattle-breeding. The Tai-yal tattoo their faces, and practise head-hunting as a religious rite. A human head is required at the opening of every public ceremony, and when a dispute occurs between two tribesmen, the decision is given in favour of the one who first secures a human head; and again, on a Tai-yal youth attaining his majority he has to bring in a human head, and now, preferably, of a Japanese, before he can be consecrated a member of the tribe. The Japanese are proceeding in their task of raising these primeval savages higher in the scale of humanity very much on the same lines as we have been following for a century past with the wild tribes of Central and Southern India,—in patience and quietness, and with equal steadfastness and sagacity, and the most merciful forbearance; only, as in all else they do, in this also, they seem to be more thoroughgoing than ourselves, judging from the greater success of their efforts, and probably because these are more scientifically directed. At least they never allow mercy to be degraded to sentimentality; never paltering with lawlessness and violence. One of their great "means of grace" in the art, or rather, the religion of civilisation, is in laying down roads everywhere. They have run a railway from the extreme north-east of the island, all down its western side to within thirty miles of South Cape; and a "trolly-road" right through the Ami country, from Karenko on the north to Taito on the south. But their most successful feat has been in establishing "a guard line" between the semi-civilised, and, under their direction, the increasingly civilising western side of the island, and its still wildered eastern side; and also between the murderous Tai-yal tribe, and the other more progressive aboriginal tribes.

And the book itself stands out so stridently for a wonder and a sign! To begin with, it is, speaking of its mere material substance and structure, but a "Blue Book," or a "Yellow Book," and of the Government of Japan. Yet it is written in English, and pure, simple, and clear English, and although printed and published at Taihoku, a place-name English people have never heard of before, it is perfect in its paper, in its typography, and its "get up"; in everything that constitutes it *un livre de bonne foi*, as the French so expressively say. In its maps and photographs it is equal

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to anything we do with such official publications, in England, and in its binding far superior to any of our bindings of to-day of any class of utilitarian books. Except in its maps, it is superior in every detail to what we have as yet done in India, even at Bombay, and Calcutta, and Madras; and I can only compare it as a sample—and an example!—with the volume on "Farm Weeds" recently issued by the Government of Canada and reviewed by me in our *Journal* of December 1st last. The monogram on the titlepage is of two equilateral triangles placed base to base, with the upper one open at the apex, like the "triangle" used in military bands, the whole wreathed in with two sprays of chrysanthemum. Mr. I. Tokugawa, the Attaché to the Japanese Embassy, has most courteously informed me that it is not only a symbol, but a Chinese "character," Tai, the first syllable of the Chinese [and Japanese] name, Tai-wan, of the Island of Formosa. It is a charming monogram. The book is indeed an omen; and a most portentous one, when you know that the same perfection of workmanship is shown by the Japanese in all to which they ever put their hands, from the imitation of English books to the reproduction of English warships.

GEORGE BIRDWOOD.

KÖNIGLICH-SÄCHSISCHE PORZELLANMANUFAKTUR, MEISSEN. By Dr. K. Berling. Meissen: The Royal China Manufactory. £2 or $10.

China has been manufactured in the country whose name it bears for upwards of a thousand years, but it was not until early in the eighteenth century that the problem of making pure white porcelain was solved in Europe. At that time Friedrich August I., generally called August the Strong, was Elector of Hanover; he was possessed of a great thirst for knowledge and a laudable passion for encouraging the arts and manufactures of his country. When he heard of the fame of young Johann Friedrich Boettger, who was gaining a great reputation as a chemist or alchemist, he sent for him. For some reason or other Boettger fled, but in 1701 he was caught and brought to Meissen. The rumours that he had found the philosopher's stone and the art of making gold proved to be ill-founded; but such was his success in manufacturing, first, earthenware pottery and afterwards pure white china, that in 1710 the Elector decided to found a factory in Meissen over which he appointed Boettger to rule supreme.

Such was the origin of the famous factory which for two centuries has continued to supply the world with Dresden china. During this long period there have naturally been many ups and downs—periods of great success, and periods of disaster—but the factory has contrived to weather all storms, and in 1910 it celebrated the two hundredth anniversary of its foundation. On this occasion Dr. Berling was invited to write a history of the factory, and this sumptuous work is the result. It consists of some 190 folio pages, which relate the history of the factory and contain careful descriptions of many of the works produced. To the expert in china one of the most valuable features of the book lies in the fact that Dr. Berling has for the first time traced a great many of the best-known pieces to the artists who made them. Another admirable feature is the 377 illustrations which were prepared under the supervision of Professors Hoesel and Achtenhagen, and which give a complete pictorial history of Dresden china. Mention should also be made of the chapter on the chemico-technical working of the factory by Dr. Heinze, and the sketch of the organisation, financial management and social statistics of the royal china factory by Privy Counsellor of Commerce Gesell.

The edition before us is in English—a compliment which has presumably been paid to this country because of the numerous patrons it has provided to the factory. Upon the whole the translation has been well done, but it is marred by a good many obvious, if unimportant, slips, which could have been easily corrected by an English eye. One does not, however, wish to cavil at these; one prefers to look at the work as a whole, and to congratulate the Meissen factory and Dr. Berling upon having given us a worthy memorial of a great occasion.

GENERAL NOTES.

ACCIDENTS IN COAL MINES.—In reply to a question asking how many workmen were killed or injured in the coal mines of the United Kingdom during each of the past ten years, the Home Secretary has furnished the following figures:—

Year.	Number killed.	Number injured as reported to the Inspectors.	Number injured and disabled for more than 7 days.
1902	1,024	3,745	—
1903	1,072	3,822	—
1904	1,055	3,754	—
1905	1,159	3,646	—
1906	1,142	3,839	—
1907	1,245	5,892	—
1908	1,308	5,860	141,851
1909	1,453	5,859	153,306
1910	1,775	5,737	159,042
1911	1,259	(Not yet available.)	

The figures in the last column were obtained for the first time in 1908 under the provisions of the Notice of Accidents Act, 1906, and cannot be

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given for the preceding years. The table speaks eloquently of the terrible dangers of the collier's life. On an average some four men are killed every day, and five hundred disabled for more than seven days.

CANADA'S RAILWAY PROGRAMME, 1912.—Railroad construction last year in Canada reached high-water mark, nearly 2,000 miles of new railway having been built. Canada's total railway mileage has thus been brought up to 26,500 miles. The building programme for the present year seems to insure as great, if not greater, activity. Sir Thomas Shaugnessey states that the Canadian-Pacific Railway will probably build five to six hundred miles of new track, and that the main line from Medicine Hat westward for 500 miles is to be double tracked. The company will thus secure a double line of railway from the head of Lake Superior to the Rocky Mountains, a distance of 1,200 miles. The Grand Trunk Pacific contemplates building 1,100 miles of railway, 200 of which will represent the main line in British Columbia and the balance branch lines in the prairie provinces. The Canadian Northern will spend a million sterling on their system in British Columbia, in addition to a large expenditure on their main line north of Lake Superior, for the completion of which they raised the huge loan of nearly seven millions sterling in London at the close of last year.

"SHAKESPEARE'S ENGLAND" EXHIBITION.—This exhibition, promoted and organised by Mrs. George Cornwallis-West in support of the Shakespeare Memorial Fund, will be held at Earl's Court from May to October. Inside the permanent buildings and in that portion of the grounds known as the Queen's Gardens will be erected a replica of an English town of the sixteenth century, with streets lined with houses of characteristic Elizabethan architecture. These houses will be available as shops for the use of firms of high standing. Performances will be held in a replica of Shakespeare's own theatre, the "Globe," while a copy of the old "Fortune Theatre" will be given up to folk-songs and Morris dances.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

MARCH 27.—THEODORE E. SALVESEN, "The Whaling Industry of To-day." LORD SANDERSON, G.C.B., K.C.M.G., will preside.*

APRIL 17. — JOHN HENRY COSTE, F.I.C., "Municipal Chemistry." DR. RUDOLPH MESSEL, F.R.S., will preside.

APRIL 24.—GEORGE FLETCHER, "Technical Education in Ireland."

MAY 1. — WILLIAM BURTON, M.A., F.C.S., "Ancient Egyptian Ceramics."

MAY 8.—E. D. MOREL, "British Rule in Nigeria."

MAY 15. — ERNEST KILBURN SCOTT, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." SIR WILLIAM RAMSAY, K.C.B., Nobel Laureate, F.R.S., will preside.

MAY 22. — GORDON CRAIG, "Art of the Theatre." MISS ELLEN TERRY will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

APRIL 25.—SIR JOHN O. MILLER, K.C.S.I., "The Central Provinces."

MAY 16.—NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

MARCH 26.—LEONARD LOVEGROVE, "British North Borneo." * EARL BRASSEY, G.C.B., will preside.

MAY 7.—ALAN BURGOYNE, M.P., "Colonial Vine Culture."

MAY 21.—THE HON. J. G. JENKINS, "Australian Railways."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." Three Lectures.

Syllabus.

LECTURE II.—MARCH 25.—*Fresco and its Modifications.*—The nature of plaster—Chemistry of fresco process—Practical details—Quality of the result—Limitations—Nature and selection of pigments—Problem of durability—Protection of surface—Modifications of the process—Fresco-secco — Stereochrome — Keim's process — Oxy-chloride process—Possibilities of development.

LECTURE III.—APRIL 1. - *Oil and Tempera Painting.* — Tempera: technical principles on which it depends—Nature and use of natural and artificial emulsions—Yolk of egg—Casein, etc.—Protection of the surface—The problem of varnishing. Oil painting: the technical principles on which it depends—Its scope and facilities—The question of durability—Limitations as regards ground—Modifications of oil painting—Use of wax—Spirit fresco—Resins and varnishes—Oil tempera.

HOWARD LECTURES.

Monday evenings, at 8 o'clock:—

CAPTAIN H. R. SANKEY, R.E., M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

* These papers will be illustrated by lantern views and by the cinematograph.

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MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Noel Heaton, "Materials and Methods of Decorative Painting." (Lecture II.)

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. D. Carruthers, "Exploration in Central Asia."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Messrs. W. Palin Elderton and R. C. Fippard, "Notes on the Construction of Mortality Tables."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. C. F. A. Voysey, "Patriotism in Architecture."

TUESDAY, MARCH 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. Leonard Lovegrove, "British North Borneo."

Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Annual General Meeting.

Swedenborg Society, at the Suffolk-street Galleries, Pall Mall, S.W., 7.30 p.m. Professor Sir W. F. Barrett, "Swedenborg's Philosophy in the Light of Modern Science."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. T. R. Holmes, "Ancient Britain." (Lecture III.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Discussion on Papers. (*a*) Messrs. A. B. McDonald and G. M. Taylor, "The Main Drainage of Glasgow"; (*b*) Mr. W. C. Easton, "The Construction of the Glasgow Main-Drainage Works"; (*c*) Mr. D. H. Morton, "Glasgow Main Drainage: the Mechanical Equipment of the Western Works and of the Kinning Park Pumping-Station." 2. Messrs. E. L. Mansergh and W. L. Mansergh, "The Works for the Supply of Water to the City of Birmingham from Mid-Wales."

Photographic, 35, Russell-square, W.C., 8 p.m. Messrs. J. and E. Rheinberg, "The Micro-Spectra Method of Colour Photography by Prismatic Dispersion."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. J. A. J. de Villiers, "The Boundaries of British Guiana."

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Mr. S. W. Melsom, "Dry Batteries: the Relation between the Incidence of the Discharge and the Relative Capacity of Cells of Different Manufacture." 2. Dr. R. B. Denison, "Contributions to the Knowledge of Liquid Mixtures." (Parts I. and II.) 3. Messrs. L. S. Bagster and B. D. Steele, "Electrolysis in Liquefied Sulphur Dioxide." 4. Dr. A. C. Cumming, "The Elimination of Potential- due to Liquid Contact." Part II. 5. Messrs. E. P. Perman and T. W. Price, "Vapour-Pressure of Concentrated Aqueous Solutions."

Quekett Microscopical Club, 20, Hanover-square, W., 8 p.m.

WEDNESDAY, MARCH 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Theodore E. Salvesen, "The Whaling Industry of To-day."

Geological, Burlington House, W., 8 p.m.

Naval Architects, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C. (Annual Conference), 11.30 a.m. 1. Address by the President. 2. Admiral Sir Reginald Custance, "Some Military Principles which bear on Warship Design." 3. Professor W. Hovgaard, "On Turning Circles." 4. Dr. T. E. Stanton, "The Law of Comparison for Surface Friction and Eddy-making Resistances in Fluids." 5. Mr. G. S. Baker, "Description of the William Froude National Tank." (Part II.)

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Mr. T. S. Moore, "The Best Poetry."

St. Paul's Ecclesiological Society, Chapter House, St. Paul's, E.C., 8 p.m.

Economics and Political Science, London School of, Clare-market, Kingsway, W.C., 7.15 p.m. Mr. Harold Jeans, "The Economics of the Iron Trade." (Lecture II.)

THURSDAY, MARCH 28...Naval Architects, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C. (Annual Conference), 11.30 a.m. 1. Mr. W. I. Knudson, "Results of Trials of the Diesel Engined Sea-Going Vessel 'Selandia.'" 2. Mr. A. C. Holzapfel, "Gas Power for Ship Propulsion." 3. Messrs. George Idle and G. S. Baker, "The Effect of Bilge Keels on the Rolling of Lightships." 4. Mr. A. Cannon, "Results of Calculations regarding the Effect of an Internal Free Fluid upon the Initial Stability and the Stability at Large Angles in Ships of Various Forms."

7.30 p.m. 1. Monsieur G. Hart, "On the Solignac-Grille Boiler and its Application in French Channel Steamers." 2. Mr. Harold E. Yarrow, "Results of Experiments on Water-tube Boilers, with Special Reference to Superheating."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study Society, 90, Buckingham Palace-road, S.W., 7.30 p.m. Miss Beatrice Edgell, "The Experimental Study of Memory."

Chemical, Burlington House, W., 4.30 p.m. Annual General Meeting. Presidential Address by Professor P. Frankland, "Some Stereochemical Problems."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. F. A. Dixey, "Sexual Dimorphism in Butterflies." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. W. Mark Webb, "The Uses of Colour to Animals."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Dr. J. A. Fleming and Mr. G. B Dyke, "The Power Factor and Conductivity of Di-electrics when tested with Alternating Electric Currents of Telephonic Frequency at Various Temperatures."

FRIDAY, MARCH 29...Naval Architects, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C. (Annual Conference), 11.30 a.m. 1. Professor J. H. Biles, "Geared Turbine Channel Steamers, 'Normannia' and 'Hantonia.'" 2. Monsieur P. Sigaudy, "Performance on Service of the Channel Steamer 'Newhaven.'" 3. Mr. F. R. S. Bircham, "On the Measurement and Automatic Recording of Dead Reckoning." 4. Commander G. J. Baugh, "Description of a Tide Indicator."

7.30 p.m. 1. Mr. A. Welin, "The Arrangement of Boat Installations on Modern Ships." 2. Dr. L. Gumbel, "Torsional Vibrations of Elastic Shafts of any Cross Section and Mass Distribution, and their Application to the Vibration of Ships." 3. Professor W. E. Dalby, "Load Extension Diagrams obtained Photographically with an Automatic Self-contained Optical Load-extension Indicator."

Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir J. J. Thomson, "Results of the Application of Positive Rays to the Study of Chemical Problems."

SATURDAY, MARCH 30....Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Molecular Physics." (Lecture VI.)

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Journal of the Royal Society of Arts.

No. 3,097. VOL. LX.

FRIDAY, MARCH 29, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, APRIL 1st, 8 p.m. (Cantor Lecture.) NOEL HEATON, B.Sc., F.C.S., "Materials and Methods of Decorative Painting." (Lecture III.)

Further details of the Society's meetings will be found at the end of this number.

COLONIAL SECTION.

Tuesday afternoon, March 26th; EARL BRASSEY, G.C.B., in the chair. A paper on "British North Borneo" was read by MR. LEONARD LOVEGROVE.

The paper and discussion will be published in a subsequent number of the *Journal*.

CANTOR LECTURE.

On Monday evening, March 25th, MR. NOEL HEATON, B.Sc., F.C.S., delivered the second lecture of his course on "Materials and Methods of Decorative Painting."

The lectures will be published in the *Journal* during the summer recess.

CONVERSAZIONE.

The Council have decided that the Society's Conversazione shall in future be held biennially instead of annually, and that no Conversazione shall be held this year.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, March 14th, 1912; SIR THEODORE MORISON, K.C.I.E. (Member of the Council of India), in the chair.

THE CHAIRMAN announced that, as Mr. Gait was still in India, Mr. J. D. Anderson, I.C.S. (retired), had kindly undertaken to read the paper. He would point out that the paper represented only a few of the first-fruits of Mr. Gait's Census Report. A great deal of the most interesting matter—that which related to anthropological researches — was not indicated in it; for that they had to wait for t full report.

The paper read was—

THE INDIAN CENSUS.

By E. A. GAIT, I.C.S., C.I.E.,
Census Commissioner for India.

INTRODUCTORY REMARKS.

When I was asked to read a paper on the Indian Census taken on the 10th March, 1911, my first impulse was to suggest that the task should be entrusted to the more experienced hands of my old friend and mentor, Sir Athelstane Baines, who, as Census Commissioner for India in 1891, gave me my first lessons in census taking, and who since then has achieved well-earned distinction in a wider statistical arena. I reflected, however, that great changes have occurred during the last twenty years, both in local conditions and in certain branches of census procedure, and my intimate connection with the last two censuses seemed, therefore, to afford some justification for my attempting the task.

It is barely a year since the census was taken. Some of the final tables are still incomplete, and none of the provincial reports have yet been sent in. It is, therefore, impossible, at this stage, to deal at all with certain branches of the subject, such as migration, caste, and occupation; and even where the bare figures are available, it would be unsafe to build too large an edifice on them until they have been subjected to a more detailed examination than has hitherto been found possible. I propose, therefore, in this paper to confine myself to a presentation of the main features of the statistics, and a discussion of the

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broad conclusions to be drawn from them. At the time of writing, the revision of provincial boundaries, in accordance with the changes announced at Delhi by His Majesty the King-Emperor, has not been finally settled. In the two Tables A and B appended to this paper, I have, therefore, given the main statistics for the provinces as constituted at the time of the census.

Previous Censuses.

Although in some provinces it had long been the practice to make periodic estimates of the population, the first attempt to do so throughout India was carried out in the years 1867 to 1872. But even then the census was non-synchronous; the methods followed in different parts were far from uniform, and the information collected and tabulated varied from province to province. The first synchronous census on a uniform plan was taken in 1881. The arrangements for it were made by the late Sir Charles Elliott, who was the first to hold the appointment of Census Commissioner for India. He took up the work with his characteristic energy and thoroughness, and although the procedure has been steadily improved at successive enumerations, it still follows the general lines which he laid down thirty years ago. Sir Charles was transferred to a higher appointment before the operations had been completed, but he never ceased to take a close personal interest in the subject, and seven years ago he read before this Society a most interesting paper on the census of 1901. Since 1881 a general synchronous census has been taken every ten years.

The Arrangements for taking the Census.

In India, with its teeming population, its great distances, and its varied local conditions, a census presents difficulties which can only be overcome by careful organisation and a judicious combination of close supervision and decentralisation, and in particular by the creation of a complete and well-drilled graded staff, the officers in each grade being carefully linked up with those above and below, so as to provide a ready ladder of communication between the top and the bottom of the structure. As on previous occasions, the District Officer was responsible for the arrangements in his district, and the Tahsildar, Sub-Inspector, or Township Officer, for those in his tahsil, thana, or township. Each tahsil, etc., was divided into circles under supervisors, and each circle into blocks containing forty to forty-five houses, under the enumerators who actually took the census. The total number of supervisors and enumerators was about two millions.

Owing to the widespread illiteracy of the population, the schedules in India (with a few exceptions) are filled in, not by the householders, but by the enumerators. In the first instance, classes were held at which each grade of census officer was trained by some officer of a higher grade. A rough draft of the census record was prepared by the enumerators a few weeks beforehand for all persons ordinarily residing in their blocks. This was carefully checked by the supervisors and other superior officers, and was then copied into the schedules. On the night of the census the record was brought up to date by striking out the entries relating to persons no longer present, and filling in the necessary particulars for new-comers. Some errors, of course, remained—chiefly in the age column—but, on the whole, thanks to the careful preliminary training and the subsequent examination of the schedules, it may be said that the work was well done. The entries, at any rate, were, as a rule, more accurate than those made by the limited number of private persons (chiefly Europeans) who filled in the schedules for themselves and their families. In the latter, owing to failure to read the instructions, numerous errors came to light. A High Court judge, for instance, included in his schedule a relative who was absent for a few days, and who was thus enumerated twice over, while an hotel-keeper and his wife put themselves down on a single line, noting "2" as their serial number, and "actual work" as their occupation. One old spinster, thinking, perhaps, that she was at last signing the marriage register, entered "full age," instead of the actual number of years she had lived; and another, seeing an insult in the question "whether able to read and write," instead of a simple "Yes," wrote "perfectly well educated." The superiority of the work done by trained enumerators to that of individual householders is now so well established that the tendency is to discourage the issue of private schedules, even to Europeans, and, as far as possible, to get the whole record prepared by the enumerators.

The Provisional Totals.

The efficiency of the organisation is shown by the great speed with which the provisional totals were got in. According to the instructions, each enumerator on the morning after the census was to prepare a statement showing the population of his block, and hand it to his supervisor,

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who, after checking it, was to prepare a total for his circle and take it to his charge superintendent. The latter was similarly to prepare a total for his charge, and send it to the District Officer, who added up the charge figures and reported the district total by telegraph. This work was so admirably done that the results for the whole of India were received complete on the 19th March —*i.e.*, within nine days of the census—and were issued in print next day with full details, not only for Provinces and Agencies, but also for districts and states and the principal towns. This constitutes a world's record. Not even in the smallest European States are the provisional totals published with the despatch attained in India. The accuracy of the figures thus obtained is also noteworthy. The net difference in the whole of India between them and those arrived at after detailed tabulation was only ·04 per cent., and for nearly half of this a mistake in one district in Burma was responsible.

The returns for many districts, states, and even provinces came to hand much sooner. Within four days of the census the figures had already been reported for a population of 134 millions, while on the sixth day they had been ascertained for 238 millions, or nearly four-fifths of the whole. The record was broken by two Native States (Rampur and Sarangarh), where the census staff set to work to prepare the provisional totals the moment the final census had been completed, and, by dint of working all night, were able, with the aid of mounted messengers and other means of conveyance, to get the figures for all parts of the state to headquarters in time for the telegram reporting the result to reach Calcutta by 8 a.m. on the following morning. The provisional totals for the Kashmir State, with its sparse population and bad communications, were ready within four days of the census, although in some cases the local figures had to be carried for upwards of two hundred miles over snow-covered passes and across rivers swollen by the heavy rain which fell on the 10th March and following days. In one of the Himalayan districts of the United Provinces, where the difficulties were equally great, two forest peons carrying the figures from an outlying circle lost their lives in trying to cross a river in flood. The Bastar State has an area of 13,000 square miles, and a sparse and primitive population, who a few months previously had risen against their chief. It is 150 miles from any railway, and there are very few roads. The local results were brought in by relays of policemen posted every few miles, and the telegram announcing the total for the state reached Calcutta on the fourth day after the census. It may be noted, as a matter of curiosity, that in Balaghat a man-eating tiger, which was holding up all night traffic, was shot by the Deputy Commissioner just before the census, and the enumerators were thus enabled to go about their work unmolested.

The above are only a few instances illustrating the devotion to duty which animated all ranks of census officers, and which is all the more remarkable when it is remembered that very few of them received any payment for their services. Nor was it only the actual staff who vied with each other in making the census a success. Private owners of horses, camels, and even motor-cars, were most generous in lending them in order to facilitate the speedy transmission of the figures to district headquarters.

I venture to think that the above details are of interest, not merely as showing the efficiency of the census organisation, but also as proof of the public spirit and loyalty of the staff, and of the knowledge of the people, tact, energy, and administrative capacity of the District Officers, in Native States as well as in British territory, on whom fell the brunt of making and carrying through the local arrangements for the census.

Special Arrangements.

Amongst the peculiar difficulties of an Indian census may be mentioned the long lines of railway, the big rivers on which boats travel sometimes for days without coming to the bank, the forests to which wood-cutters resort, often for weeks at a time, and the numerous sacred places, which, on occasion, attract many thousands of pilgrims. It would be tedious to describe all the special arrangements which were made in these and similar cases; it must suffice to give a brief outline of the measures taken on the railways. All persons travelling by rail who took tickets after 7 p.m. on the night of the census were enumerated on the platform, if there was time, and, if not, in their train. Those alighting at any station during the night were enumerated there unless they could produce a pass showing that they had already been counted. All trains were stopped and every carriage visited about 6 a.m. on the following morning, in order to include any travellers who up till then had escaped notice. At one large junction alone sixty special enumerators were engaged for the census of travellers by rail.

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The Tabulation of the Results.

In the matter of taking the census, there has been no material change of system since 1881. In connection with the tabulation of the results, however, a new departure was made in 1901, when the slip system, which was first used by Dr. Georg von Mayr at the Bavarian census of 1871, was substituted by the late Sir Herbert Risley for the old method of abstraction by ticks. Under this system a separate slip is prepared for each person, on which all the necessary particulars regarding him are noted. The slips used on the present occasion measured 4½ in. by 2 in.; religion was denoted by the colour of the slip, and sex and civil condition by symbols printed on it. The amount of writing required for the other entries was reduced by means of abbreviations; and one man was thus able, on the average, to prepare about five hundred slips a day. It may be interesting to note that these slips, placed end to end, would form a narrow band of sufficient length to encircle the world at the equator. After the slips had been prepared, they were compared with the original entries in the enumeration books, and the number of each sex was checked with the enumerator's abstract. If any difference was disclosed, the slips were again compared with the books. Those for each circle were then sorted by sex and religion, after which all the slips of the same sex and religion were thrown together for the tahsil or other unit, and sorted and re-sorted for the different tables. This method of work is not only much simpler and more expeditious than the one which it superseded, but it is also more accurate and can more easily be tested.

In 1901, the slip system being new to India, the local superintendents were allowed considerable latitude in the methods of applying it. At the present census, in the light of the experience then gained, a general code was prepared, on the basis of which provincial superintendents drew up their instructions, with such modifications as were necessary in view of local conditions.

The Information Collected and Compiled.

The information collected included, as usual, sex, age, religion, civil condition, caste or race, occupation (including subsidiary occupations and the means of subsistence of dependents), language, birthplace, education, and certain infirmities. Sect was recorded for Christians, and, in some provinces, for other religions also. In a few provinces the sub-caste was entered as well as the caste. A new feature was the use of a separate schedule for obtaining information regarding persons working in factories and other industrial undertakings in which not less than twenty hands were employed. Special returns were also obtained of persons working on railways and canals, and in the Postal and Telegraph Departments. In this way a good deal of information has been collected which cannot be got from the occupation columns of the ordinary census schedules.

Changes in the form of the final tables are to be deprecated, as they impede comparison with the results of previous enumerations. The only material alteration made on the present occasion was in the occupation tables. It had already been recognised that the Indian classification was too elaborate, and the opportunity was taken, while simplifying the scheme, to recast it in accordance with the one drawn up some years ago by M. Bertillon, and recommended for general adoption by the International Statistical Institute. In doing so, the more important detailed heads of the previous scheme were retained unaltered, so that it will still be possible to compare the main figures with those of 1901.

Population and Density.

The total population of India is now 315 millions, of whom three-fourths are resident in British territory and one-fourth in Native States. The mean density of the population is 175 per square mile, but there are great local variations; from 900 and upwards in a few favoured districts of Bengal, to less than fifty in Burma, Kashmir, the west of Rajputana, and Baluchistan. In the last-mentioned province, including its states, there are only six persons to the square mile. Apart from past political conditions, the rainfall is the main factor in determining these variations, but the configuration of the surface and the nature of the soil are also of importance. The density is greatest in the Gangetic plain, where the rainfall is ordinarily ample and the soil is a level alluvium, practically every inch of which is cultivable except where it is covered with water. The next most thickly inhabited tracts are two narrow strips along the coast on each side of the peninsula. Gujarat, though it has been called the "garden of India," supports barely a quarter of the number of persons per square mile found in the delta of Bengal. Its rainfall is more scanty and less regular than that of Bengal, the surface is somewhat undulating, and the soil more sandy. The low density in

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Burma is due to historical reasons; with the advent of a settled government the population is rapidly increasing. In the elevated tract in the centre of the peninsula, not only is the rainfall comparatively light and uncertain, but the surface is broken and irregular, and the soil is often thin and stony. In western Rajputana, Sind, the south-west of the Punjab, and Baluchistan, the rainfall is so scanty that very little cultivation is possible without the aid of irrigation. That the soil itself is fertile enough is shown by the large yield of wheat in the canal colonies of the Punjab.

There is at present no general correlation between irrigation and density of population. In the tracts where the density is greatest the rainfall in ordinary years is ample, and there is no need for an artificial supply of water. Where, on the other hand, the rainfall is scanty or very precarious, the population has hitherto been sparse, and the canals which have been constructed have not yet had time to produce their full effect. It may be mentioned in passing that the construction of irrigation works has often been accompanied by a deterioration in the public health, due to the spread of malaria. The question of malaria prevention is one of India's most urgent problems; and it is earnestly to be hoped that success may attend the efforts which are now being made to cope with it.

Growth of Population.

The population has grown by 53 per cent. since 1872. Part of this increase, however, is due to the inclusion of new areas, and part to the greater accuracy of recent enumerations. The following statement shows, as far as can now be ascertained, how far it is attributable to these causes and what the actual growth of the population is believed to have been:—

Period.	Increase due to — Inclusion of new areas.	Increase due to — Improvement of method.	Real increase of population.	Total.	Rate per cent. of real increase.
	Millions.	Millions.	Millions.	Millions.	
1872–1881	33	12	3	48	1·5
1881–1891	5·5	3·5	25	34	9·8
1891–1901	2·5	·2	4·3	7	1·5
1901–1911	1·5	...	19	20·5	6·4
Total	42·5	15·7	51·3	109·5	19·3

Note.—The total percentage of real increase has been calculated on the assumption that the rate of increase has been the same in the "new" areas as in the old.

The fluctuations from one decade to another reflect the intimate connection which exists in an agricultural country between the harvests and the growth of the population. In the first of the above periods a series of bad seasons, culminating in the great famine of 1876–78, kept the population almost stationary. The next decade was one of general agricultural prosperity, and the increment was large in consequence. Between 1891 and 1901 there were two widespread and disastrous famines, which not only caused a heavy fall in the birth-rate, but also, with the diseases which followed in their train, led to a mortality, chiefly in the Native States, of about five millions in excess of the normal. The ensuing ten years, though marked by a few local famines, were, on the whole, favourable to agriculture, and the result has been an accelerated growth of population. The increase would have been far greater but for the extremely unfavourable state of the public health in Upper India. Malarial fevers were terribly prevalent in the irrigated tracts of the eastern and central Punjab, and in the Ganges-Jumna Doab in the United Provinces. Plague also caused great havoc in these provinces and Bombay, and in parts of Bihar and the Central Provinces; the total recorded mortality from it during the decade in British territory was six and a half millions. These diseases caused a decline in the population of the Punjab and United Provinces of about half a million in each case, when otherwise—at least, in the Punjab—a large increase might have been looked for.*

The variations which have occurred during the last ten years in individual provinces and states are shown in Table B. It will be seen that while, taken as a whole, British territory has an increase of 5·5 per cent., the Native States have gained 13 per cent. Some of these states had lost heavily in the famines of the previous decade, when they showed a net decrease of 5 per cent., compared with an increase of 4·7 per cent. in British territory, and many of them are still so sparsely populated that there is much more room for growth than there is in most British provinces. Taking the district or state as the unit, it may be noted that 332 units, with a population in 1901 of 223 millions, have gained 11 per cent., while 86, with a population of 71 millions, have lost 5·3 per cent.

It has sometimes been assumed that the increase during the ten years ending in 1891

* It will be shown further on that the excess mortality occurred chiefly amongst women. The result will be a diminished birth-rate in the immediate future.

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represents the normal rate of growth in India, or the rate which might always be expected to obtain were it not for famine and other similar calamities. That decade, however, like the one which has just come to a close, followed on a period of famine, with a retarded birth-rate and a heavy death-rate. The excess mortality in the famine years had occurred mainly amongst the very old and the very young: persons in the prime of life—*i.e.*, at the child-bearing ages—were but little affected. The conditions were thus favourable to an abnormally rapid growth of population. With restored fecundity and an undiminished number of persons at the child-bearing ages, the number of births would be greater than usual. On the other hand, there would be far fewer deaths, since so many of the "bad lives," which would otherwise have swollen the mortality, had already disappeared. This rebound after famine is always very marked. In Madras the famine of 1876–78 caused a slight setback at the ensuing census. This was followed ten years later by an increase of 15·6 per cent. The rate of growth fell to 7·3 per cent. in 1901, and it has now risen to 8·3 per cent. The comparatively small figure for the decade 1891–1901 was probably an aftermath of the famine, the new generation of potential parents being smaller than it would otherwise have been. The Central Provinces and Berar afford another instance of rapid recovery from famine losses. Owing to the famines of 1897 and 1900, the population in 1901 showed a decrease of 8 per cent. In the last Census Report for India, I pointed out that this loss had occurred entirely at the two extremes of life, and predicted that, in the absence of any fresh calamity, it would be made good before many years had elapsed. This forecast has proved correct. The increase during the ensuing decade was no less than 16 per cent.

The growth of population depends not only on the prevailing sanitary and material conditions, but also on the sex proportions and on the age constitution, which is constantly changing. There is no such thing as a normal rate of increase. All that can be said is that since 1872 the average increment has been about 5 per cent. per decade. If the population were to continue to grow at the same rate, it would double itself in about a century and a half. Compared with the Teutonic races, this rate of increase is very moderate, but it is greater than that of the Latin nations. The birth-rate in India is high, but so also is the death-rate. The mortality amongst children is particularly heavy, especially during the first year of life, when it sometimes exceeds one-third of the number born. With the advance of sanitary science, this mortality will no doubt be reduced, but even so, a greatly accelerated growth of the population cannot be expected so long as it continues to be so largely dependent on agriculture.

It is difficult to form any estimate of the additional agricultural population which India is capable of supporting with the present methods of cultivation. There are extensive areas where there is still scope for expansion, especially where irrigation can be carried out on a large scale. The largest and most successful of the completed irrigation schemes is the one by which several thousand square miles of waste land in the Rechna Doab have been converted by the lower Chenab canal into a most prosperous wheat-growing tract. It was previously inhabited only by a few pastoral nomads, numbering in 1891 at the most 70,000; but as soon as the canal began to be effective, immigrants flocked in. By 1901 the population had already risen to 792,000, and ten years later to 1,071,000. It has been estimated that it will ultimately reach two and a half millions. On the other hand, there are tracts—chiefly in the United Provinces and Bihar—where there seems to be scarcely any room for further growth. Mere density, however, is not always a safe criterion. Some of the most thickly-peopled districts of East Bengal are still growing very rapidly. Dacca, with 952 persons to the square mile in 1901, has added 11 per cent. to its population, and Tippera, with 848, nearly 15 per cent. The people of these two districts are extremely prosperous, and there is no reason to suppose that the limit of expansion has been reached.

The Urban Population.

There is nothing new to say regarding the general distribution of the urban population. In India, as a whole, only about one-tenth of the inhabitants live in towns. The proportion is lowest in the north-east and extreme north-west of India, and highest on the west coast. Contrary to experience in Europe, where the domestic servants are mostly women, the proportion of females to males is usually less in urban than it is in rural areas. As might be anticipated from their occupations, an exceptionally large proportion of the Parsi and Jain communities reside in towns. According to the census, the urban population has grown since 1901 by ·3, and the rural by 7·8 per cent. The figures, however, are vitiated by the fact that at the time of the census plague was raging in many towns, chiefly

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in the United Provinces, the Central Provinces, and Central India, and large numbers of the regular inhabitants had gone away. A fresh count taken a few months later often gave far larger figures than those of the general census—*e.g.*, in Nagpur, where the difference was no less than 33 per cent. Calcutta, with its suburbs and Howrah, now has a population of nearly a million and a quarter. The increase during the decade is 10 per cent., or less than half that during the previous ten years. In Calcutta proper the increase is less than 6 per cent., but in the suburbs of Maniktola and Garden Reach it is nearly twelve times as great. Owing to the removal of slums and improvements in the means of locomotion, the tendency is growing for workers in the city to make their home in the suburbs or even further afield; a similar tendency has been noticed in some other towns also. Bombay, with nearly a million inhabitants, shows an increase of 26 per cent., but it must be remembered that in 1901, owing to a severe visitation of plague, the population was abnormally small, being, in fact, slightly less than it had been ten years previously. The population of Madras is almost stationary. Hyderabad, the capital of the Nizam's dominions, has a gain of 12 against 8 per cent. in the previous decade, and Rangoon of 19 against 35. The largest proportional increase amongst cities, or places with not less than 100,000 inhabitants, is shown by Karachi, which has grown by 30 per cent. Dacca has added 21 per cent. to its population. Owing to plague, all the cities in the United Provinces show an apparent decline, but in the Punjab, Delhi and Lahore have increases of about 12 per cent. in spite of a falling off in the adjoining rural areas.

The Sex Proportions.

In most parts of Europe the females outnumber the males. More boys than girls are born, but the mortality amongst them is greater both in infancy, owing to physiological reasons, and in later life owing to the greater risks to which they are exposed in their daily avocations. In India, as in most other parts of the world, males are in excess. The proportion of the sexes at birth is not very different from that in Europe, but subsequent conditions are relatively less favourable to female life. Female children are not wanted, and it is well known that the practice of killing them was formerly widespread amongst certain communities, chiefly in the north-west of India. A striking instance of this came to the notice of a friend of mine a few years ago. He was discussing with the Durbar of a Native State the amount which ought to be expended on the marriage of the Chief's sister, and, as there was some difference of opinion, he asked how much had been spent on similar occasions in the past. He was told in reply that *there was no precedent*. This girl was the first in the family who had been allowed to live! A middle-aged Punjabi gentleman recently told me that he had been compelled, as a boy, to assist at the murder of his infant sister, and that an aunt had had seven daughters and killed them all. He was careful to add that his family has since abandoned such practices. But even now there is much neglect of female children. Girls are neither so well fed nor so well clothed as boys, nor, if ill, are they so carefully looked after. In Gujarat there is a proverb that "the parents look after the boys, and God looks after the girls." Early marriage and child-bearing, coupled with all the risks attendant on unskilful midwifery, are also responsible for many deaths. Speaking of the results of early marriage, the Census Superintendent of a Native State in 1901 wrote as follows:—

"Numbers of these girls march from the nuptial bed to the funeral pile. Nervous debility, consumption, and uterine diseases create a havoc among them."

These adverse conditions affecting female life would seem to be sufficient to account for the difference in the proportions as compared with Europe, but it has sometimes been attributed in part at least, to the relatively incomplete enumeration of females owing to the seclusion in which they are kept. It may be pointed out, however, that if reticence regarding females were the cause of the difference in the proportions, it would be greatest in the case of Muhammadans, but in almost every part of India the proportion of females amongst Muhammadans is greater than it is in the same locality amongst Hindus. Concurrently with the greater accuracy of each succeeding census from 1881 to 1901 there was a steady rise in the proportion of females, and it was assumed by some that there was a connection between the two phenomena. That this was not so is shown by the fact that the proportion of females has now fallen to what it was in 1881. The variations which occur from time to time depend partly on changes in the proportions at birth which, whatever their cause, are known to occur, and partly on changes in the relative mortality of the two sexes. It has been clearly established that in severe famines the mortality amongst women is less than it is amongst men. This is due to their being less

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metabolic, and to the fact that it is chiefly women who get gratuitous relief, do the cooking, handle the food supply for their children, and collect the jungle products, with which they eke out their ordinary food supplies. The rise in the proportion of females in 1901 was thus due, to a great extent, to the famines of 1897 and 1900. The diminution which has now taken place is the result of the greater mortality which has occurred amongst them from plague and malaria in Northern India. Being largely confined to their houses, women are more exposed than men to infection by plague-bearing rat-fleas and malaria-carrying mosquitoes.

It is impossible within the limits of this paper to discuss the local variations in the sex proportions in different parts of the Empire. I may mention, however, that the proportion of females is lowest in the north-west of India. This is the tract where female infanticide was formerly common, and it would take a generation for the discontinuance of this practice to have full effect on the proportions, even if there were no longer any serious neglect of female infant life. In this tract, moreover, there is a relatively high proportion of males at birth. Darwin has pointed out that this would naturally be the result of long-continued female infanticide, if it be assumed that there is a hereditary tendency to produce one sex more than the other. Girls would be killed chiefly in families where they are more numerous than boys, and spared where they are in a minority, and the survivors would thus be those with a male-producing tendency.

Religion.

The Hindus, though they form 69 per cent. of the total population, claim only half of its net increase during the decade. Owing mainly to their social customs, and especially the common prohibition of widow marriage, their natural rate of growth is relatively slow. It is difficult to draw the line between Hindus on the one side, and Jains, Sikhs, and Animists on the other. The tendency is growing for Jains to call themselves Hindus; but in the Punjab many persons returned as Hindus in 1901 have now been entered as Sikhs, and a similar change of procedure elsewhere has augmented the number of Animists. The net result has been some diminution in the number of persons recorded as Hindus. There have, besides, been losses by conversions to Christianity, and also, though to a less extent, to Muhammadanism. It may be interesting to mention that the members of the Arya Samaj are endeavouring to counteract this steady drain by taking back into caste those who are willing to return to the Brahmanical fold. But ordinary Hindus will not always accept their authority in a matter of this kind, and it is with them that the decision really rests. The Muhammadans, in spite of their greater prolificness, the reasons for which were explained in the last census report, and occasional gains from the ranks of other religions, have increased at slightly less than the average rate. This is because a quarter of their total strength is found in the two provinces which have sustained a loss of population. They have more than held their own in each province and state taken separately. The number of Christians is now nearly four millions—a gain of a million in ten years. The largest actual addition (411,000) has occurred in Madras and its Native States, which contains three-fifths of the total number of Christians in India, but the greatest proportional increase (200 per cent.) is in the Punjab. The figures for

District or State.	Number of Christians.	
	1911.	1901.
Ranchi	177,473	124,958
Jashpur	36,880	12
Gangpur	33,692	1,758

this province came as a surprise, even to some of the missionaries. Numerous conversions continue to be made amongst the aboriginal tribes of Chota Nagpur. The missions to the Khasis and other hill tribes of Assam, and to the Karens of Burma, are also highly successful. The value of the work done amongst these primitive races, moreover, must be measured not merely by the number of converts, but also by the good which the missionaries have done in other ways. It is they who have reduced the languages of these rude tribes to writing, and who have taken the lead in educating and civilising them.

Of the modern Hindu schismatics, the Brahmos have made very little progress, but the Aryas are nearly three times as numerous as they were ten years ago. They still number less than a quarter of a million, but they include in their ranks an exceptionally large proportion of educated persons.

Education.

The inquiry regarding education was limited, as in 1901, to the question whether each person was literate, and, it so, whether he could read

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TABLE A.

Province, State or Agency.	Population in 1911 in millions.	Density per square mile.	Number of females per 1000 males.	Number per 10,000 who are						Number per 10,000 who are Literate.							
				Hindus.	Musalmans.	Buddhists.	Animists.	Christians.	Others.	All Religions.		Hindu.		Musalman.		Christian.	
										Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
INDIA	**315·2**	**175**	**953**	**6,932**	**2,125**	**342**	**328**	**124**	**149**	**1,056**	**105**	**1,010**	**76**	**688**	**43**	**2,927**	**1,352**
Provinces	**244·3**	**224**	**956**	**6,689**	**2,351**	**436**	**301**	**102**	**121**	**1,131**	**111**	**1,098**	**80**	**692**	**40**	**2,946**	**1,575**
1. Ajmer-Merwara	·5	185	884	7,750	1,616		79	108	447	1,241	135	910	63	949	61	7,808	6,564
2. Andamans and Nicobars	·03	8	352	3,578	1,731	603	3,671	214	203	1,934	253	1,911	416	1,951	340	7,135	4,780
3. Baluchistan	·4	8	733	622	9,106	..	..	121	151	812	96	4,271	507	236	12	8,808	6,837
4. Bengal	52·7	455	1,004	7,648	1,782	10	495	61	4	1,174	83	1,274	82	961	45	3,014	1,928
5. Bombay	19·7	160	920	7,585	2,046	..	87	119	163	1,206	145	1,198	93	742	67	4,092	2,362
6. Burma	12·1	53	959	322	347	8,572	579	173	7	3,763	607	2,298	529	2,338	775	4,205	2,525
7. Central Provinces and Berar	13·9	139	1,008	8,261	406	..	1,254	25	54	684	32	680	21	1,669	96	5,923	4,114
8. Coorg	·2	111	799	7,939	751	..	1,099	203	8	1,570	279	1,688	284	1,8[illegible]4	160	3,605	1,940
9. Eastern Bengal and Assam	34·0	343	954	3,555	5,925	59	427	31	3	1,057	73	1,740	162	687	18	2,526	1,309
10. Madras	41·4	291	1,031	8,889	662	..	154	288	7	1,379	135	1,350	108	1,657	108	2,264	1,072
11. North-West Frontier Province	2·2	164	858	546	9,286	..	..	30	138	581	60	3,735	566	242	12	8,973	6,379
12. Punjab	20·0	205	817	3,297	5,485	2	..	99	1,117*	653	64	1,031	81	280	20	2,336	1,212
13. United Provinces	47·2	440	915	8,504	1,411	..	..	37	48	611	50	579	35	592	60	3,493	2,345
States	**70·9**	**100**	**944**	**7,788**	**1,331**	**11**	**426**	**200**	**244**	**792**	**82**	**745**	**62**	**665**	**63**	**2,893**	**960**
14. Baluchistan States	·4	5	850	282	9,643	..	..	1	74	299	2	5,525	13	96	1	8,980	6,667
15. Baroda	2·0	248	925	8,349	791	..	568	35	257	1,751	205	1,651	169	2,317	173	2,252	1,362
16. Bengal States	4·6	151	998	8,369	439	3	1,101	85	3	564	27	605	28	1,089	41	306	144
17. Bombay	7·4	116	968	8,169	1,184	..	202	17	428	1,184	115	1,022	93	1,391	88	2,878	1,548
18. Central India Agency	9·4	121	949	8,831	546	..	517	10	96	481	25	422	15	1,067	116	7,758	4,661
19. Central Provinces States	2·1	68	1,009	6,194	95	..	3,521	183	7	226	11	313	13	1,668	110	137	75
20. Eastern Bengal and Assam States	·6	46	969	6,243	1,380	104	2,266	5	2	524	37	690	50	534	25	5,534	3,243
21. Hyderabad	13·4	161	968	8,693	1,032	..	214	40	21	506	37	434	19	1,030	126	3,174	1,630
22. Kashmir	3·2	37	886	2,183	7,594	116	..	3	104	384	11	1,097	31	146	2	2,642	3,473
23. Madras States (including Cochin and Travancore)	4·8	456	995	6,903	654	..	41	2,399	3	2,385	473	2,282	382	1,681	112	2,906	846
24. Mysore	5·8	197	979	9,199	542	1	124	103	31	1,120	126	1,030	82	2,001	413	4,454	2,801
25. North-West Frontier Province (Agencies and Tribal areas)§	1·6	64	876	1,984	7,095	..	..	98	823	1,888	680	4,176	484	809	283	8,909	7,391
26. Punjab States	4·2	115	814	4,953	3,133	8	..	4	1,902†	513	28	686	28	221	13	5,962	5,722
27. Rajputana Agency	10·5	82	909	8,311	936	..	·422	4	327	594	25	480	19	439	26	6,252	5,403
28. Sikkim	·1	31	951	6,674	5	3,289	..	32	..	782	25	834	23	6,316	..	5,806	2,077
29. United Provinces States	·8	164	929	7,008	2,962	..	..	21	9	393	15	445	12	265	21	238	292

* Includes 1,048 Sikhs. † Includes 1,875 Sikhs. § The figures in columns 5 to 18 relate to trans-frontier posts only.

TABLE B.

Province or State.	Variation per cent. in Total Population.					Variation per cent. in each Religion, 1891–1911.				Variation per cent. (1901–11) in the Number of Literate Persons.					
										All Religions.		Hindu.		Musalman.	
	1901–11.	1891–1901.	1881–91.	1872–81.	1872–1911.	Hindu.	Musalman.	Sikh.	Christian.	Male.	Female.	Male.	Female.	Male.	Female.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
INDIA	**+7·1**	**+2·5**	**+13·2**	**+23·2**	**+52·9**	**+4·6**	**+16·3**	**+58·1**	**+69·9**	**+15·3**	**+60·7**	**+12·8**	**+69·2**	**+24·0**	**+51·3**
Provinces	**+5·5**	**+4·7**	**+11·2**	**+7·4**	**+31·9**	**+5·3**	**+15·9**	**+54·4**	**+67·4**	**+15·8**	**+60·2**	**+13·0**	**+70·4**	**+25·3**	**+57·2**
1. Ajmer-Merwara	+5·1	−12·1	+17·7	+16·2	+26·5	−11·1	+9·1	+332·9	+102·5	+9·5	+65·0	−1·6	+36·6	+10·6	+55·1
2. Andamans and Nicobars	+7·3	+57·9	+6·7	..	..	+·4	+15·1	+15·2	+17·2	−12·2	−22·3	−15·7	−34·7	−1·1	−55·3
3. Baluchistan	+8·5	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4. Bengal	+3·8	+2·8	+5·5	+12·3	+26·6	+5·6	+8·0	+936·7	+89·7	+11·1	+50·3	+8·5	+44·9	+23·0	+42·1
5. Bombay	+6·0	−1·7	+14·5	+1·2	+20·7	+1·8	+13·8	+1,353·2	+44·2	+13·6	+56·4	+11·6	+79·9	+32·0	+70·4
6. Burma	+15·5	+35·9	+106·6*	+36·0	+341·0	+127·1	+66·3	+111·5	+74·0	+15·8	+57·8	+46·6	+97·3	+48·8	+145·8
7. Central Provinces and Berar	+16·2	−8·3	+9·3	+20·0	+39·8	+6·9	+12·5	+530·7	+142·2	+20·9	+47·2	+19·2	+49·4	+26·8	+29·9
8. Coorg	−3·1	+4·4	−2·9	+5.9	+4·0	−11·4	+3·8	..	+4·7	+19·3	+72·0	+22·3	+94·4	+7·6	+16·9
9. Eastern Bengal and Assam	+11·5	+8·5	+10·4	+10·0	+46·9	+13·5	+24·2	+950·6	+170·5	+28·8	+66·7	+26·9	+79·4	+31·5	+41·6
10. Madras	+8·3	+7·3	+15·6	−1·2	+32·6	+15·0	+21·8	..	+37·6	+26·2	+57·8	+25·4	+68·1	+31·8	+39·6
11. North-West Frontier Province	+7·6	+9·9	+17·9	+7·0	+25·9	−28·2	−2·3	+43·7	+21·1	−5·5	+23·7	−15·1	+40·9	+4·8	−27·5
12. Punjab	−1·7	+6·9	+10·0			−13·1	+14·8	+53·0	+311·4	−3·6	+65·9	−18·0	+71·9	+5·5	+27·2
13. United Provinces	−1·1	+1·7	+6·2	+5·1	+12·3	−·6	+4·9	+33·6	+204·5	+5·8	+101·1	+1·8	+109·1	+13·3	+113·3
States	**+13·0**	**−5·0**	**+20·1**	**+162·0**	**+237·6**	**+2·7**	**+18·7**	**+68·6**	**+74·6**	**+13·0**	**+63·1**	**+11·8**	**+64·3**	**+16·3**	**+31·5**
14. Baluchistan States	−1·9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15. Baroda State	+4·1	−19·2	+10·7	+9·2	+1·8	−20·6	−14·8	+718·2	+1,015·0	+12·7	+178·1	+14·1	+256·7	+28·0	+177·9
16. Bengal States	+16·9	+7·6	+19·7	+33·5	+101·1	+33·6	+29·6	+920·0	+2,431·6	+8·8	+36·0	+6·4	+32·8	+40·7	+48·3
17. Bombay States	+7·3	−14·5	+16·5	+2·1	+9·0	−10·7	+2·8	+1,167·0	+50·6	+4·6	+70·9	+7·4	+75·6	+9·6	+20·1
18. Central India Agency	+10·1	−16·2	+9·4	..	..	+9·1	−7·7	−24·2	+56·2	−5·1	−20·5	−·1	−30·0	−24·2	−30·0
19. Central Provinces States	+29·8	−4·8	+23·4	+49·5	+128·1	−1·1	−51·9	+13,500·0	+11,350·9	+49·0	+48·4	+46·9	+61·2	+38·0	+109·6
20. Eastern Bengal and Assam States	+25·8	+233·1†	−56·6†	+798·2	+1,533·0†	+292·2	+114·2	..	+103·0	+139·4	+408·8	+164·7	+470·5	+106·5	+213·7
21. Hyderabad	+20·0	−3·4	+17·2	..	..	+12·7	+21·3	+1·9	+165·8	+10·9	+27·5	+6·3	+14·8	+27·0	+45·8
22. Kashmir	+8·7	+14·2	..	..	..	−·4	+33·7	+176·8	+347·2	+9·0	+33·8	+3·0	+96·7	+24·4	−48·1
23. Madras States (including Cochin and Travancore)	+14·9	+13·2	+10·6	+1·7	+46·3	+20·4	+39·5	..	+61·5	+30·5	+77·3	+26·1	+70·5	+28·0	+40·4
24. Mysore	+4·8	+12·1	+18·1	−17·2	+14·9	+15·1	+24·3	+910·3	+56·9	+26·9	+70·1	+26·0	+81·9	+29·6	+78·6
25. North-West Frontier Province (Agencies and Tribal areas)	+1,831·9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
26. Punjab States	−4·8	+3·8	+10·4	..	..	−16·3	+3·0	+64·4	+410·9	+2·1	+81·8	−12·0	+74·8	+20·7	+39·8
27. Rajputana Agency	+6·9	−19·0	+22·5	..	..	−15·5	−2·0	+702·7	+128·6	+3·2	+46·5	+2·8	+55·7	+5·8	+8·6
28. Sikkim	+49·0	+93·8	..	..	..	..	..	..	..	+20·6	+84·7	+7·8	+225·0	..	..
29. United Provinces States	+3·7	+1·2	+6·8	+16·1	+30·3	+6·1	+1·6	+420·0	+2,166·2	+31·3	+31·1	+42·5	+18·0	−·4	+47·9

* Includes Upper Burma, annexed in 1886

† Manipur figures were omitted in 1872 and 1891, but included in 1881, 1901, and 1911.

and write English. In 1901 no general indication was given as to the degree of proficiency in reading and writing which should qualify a person to be entered as literate, and the practice varied a good deal according to the view taken by the local officers. In Madras it was laid down that only those should be so entered who could write a letter to a friend and read his reply. This seemed as good a criterion as could be devised; and as uniformity is obviously desirable, it was this time prescribed for general adoption. Its application has in some parts led to the entry as illiterate of persons who would otherwise have been shown as literate; but in spite of this the proportion to the total population returned as able to read and write has risen during the decade from ninety-eight males and seven females per mille to 106 and 11 respectively. The progress amongst males has been greatest in Eastern Bengal and Assam, Madras and Mysore, and amongst females in Baroda and the United Provinces. The proportion of literate persons is greatest in Burma and the extreme south of India, and smallest in the north-west. The Dravidian and Mongolian elements in the population appear to be more alive to the advantages of education than the Aryan.

In India, as a whole, ninety-five males and ten females per ten thousand are literate in English. Amongst the main British Provinces Bombay leads, and the United Provinces come last. A colloquial knowledge of English is probably most widespread in Madras, but the English-speaking servant or coolie was not ordinarily returned as literate in that language.

Infirmities.

Information is collected at the census regarding four infirmities—insanity, deaf-mutism, total blindness, and leprosy. Up to 1901 there was a progressive decline in the number of persons thus afflicted, owing mainly, in 1891, to better diagnosis, and in 1901 to the famines of the preceding decade. A very large proportion of these unfortunate persons are beggars, and it is they who suffer most when scarcity occurs and the springs of private charity dry up. The last ten years have been fairly prosperous, with the result that the number of the afflicted has risen, though it is still less than it was twenty years ago. Of every 100,000 persons, 26 are insane, 64 deaf-mute, 142 blind, and 35 lepers. Blindness affects the two sexes almost equally; but the number of females returned as insane or deaf-mute is only about two-thirds that of the males, while in the case of lepers it is barely one-third. No one but a beggar will willingly say that he is a leper. This natural reticence is largely discounted in the case of males by the local knowledge of the enumerators, but there can be no doubt that many female lepers must have escaped entry as such. The figures, however, can be relied on for comparative purposes. The proportion of lepers, as compared with the abnormally low one of 1901, shows a smaller increase than do the other infirmities, and it is still much below that of 1891. It may thus, perhaps, be inferred that the disease is showing a tendency to disappear. If the latest theory that the bed-bug is the common medium of infection be correct, a decrease would naturally result from the more frequent segregation of lepers in asylums, and the steady improvement which is taking place in the material condition of the people.

DISCUSSION.

The Chairman, in opening the discussion, said the paper made one very anxious to receive the full report of the census, but from what they had heard that afternoon it appeared that the mere enumeration had been an admirable piece of administration. He also thought the great amount of public spirit shown in India by the extent and value of the voluntary services for the census should be put on record. He had been very interested to see that Mr. Gait had spoken so definitely upon the causes of that rebound of population after famine to which their attention had been called. For some time there had been a theory that the privations through which the people had passed caused an increased fecundity, and that it was an example of the *vis medicatrix naturæ* which caused the spontaneous increase of population to follow upon hardships. That rather attractive theory seemed to be corroborated by evidence of some breeders of animals. Mr. Gait, however, found other and, as appeared to him (Sir Theodore), more substantial reasons. One was that the child-bearing population was the one which survived best during famine, and that the loss of life took place at the two extremes—amongst children and the very old—so that the child-producing capacity of the population was not thereby impaired. He wondered whether some of the previous Commissioners of the Census were satisfied that some fair estimate of the rate of increase of the Indian population had now been arrived at. If Mr. Gait had placed before them reasonably reliable data for forming a calculation, it would seem that the estimates of population at the beginning of the nineteenth century—which of course were very rough—appeared to have understated the population at the time. It was said that the population at the beginning of the nineteenth century was probably 100 to 150 millions, and on the basis

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of that calculation some rather exaggerated estimates were made of the rate at which the population must have increased before the first regular census was taken. It seemed to him, speaking without any expert authority, that Mr. Gait's calculation would bring the population at the beginning of the nineteenth century more nearly to 200 millions. The sex proportions of the population had struck him as extraordinarily puzzling when the first results were brought out. There seemed to him to be no rhyme or reason in the large preponderance of males in some provinces, and the curious equality of sexes, especially towards the east of India in the two Bengals. He hoped that point would be dealt with at greater length in the full census report.

Sir William Chichele Plowden, K.C.S.I. said the paper teemed with interest from the commencement, where it dealt with the valorous bravery of the forest peons who lost their lives in their endeavours to do their duty, to the very end of it, where Mr. Gait dealt with that pestilence that "walketh in darkness," known as the bed-bug. Three points had struck him in reading the paper, firstly, the great rapidity with which the work of the census had been performed; secondly, the extraordinary increase of the Christian population; and lastly, and what was very remarkable, the increase of the literate population, especially among the women. In passing, he might mention that a table appended to the paper showed that part of the increase in the population was due to the inclusion of new areas. He hoped that a censorious public would not understand from that that Great Britain through its administration had been grabbing territory. Those new areas were not new areas by conquest, but simply old areas in which the former enumerations did not exist. He supposed there was no census in the world which had disclosed its results so quickly as Mr. Gait's census, and it certainly was essential to India to have the most rapid knowledge of the increase of its population. The extraordinary increase in the Christian population was very largely confined to aboriginal districts, especially the three districts belonging to Chota Nagpur. He had been talking to a missionary friend, who had informed him that the Bible was having a very great influence in the country. Turning to the extraordinary increase in the literate character of the population, the increase in the female literate world was remarkable when compared with the increase in the male literate world. The increase in the case of females was 50 per cent., compared with a 10 per cent. increase in the case of males. The influence that the acquisition of knowledge on the female side of the household in India would have upon the welfare of the country was something upon which Indian officials might very well dwell with great satisfaction. The changes in the country were vast and extraordinary. To him, who had been away from India thirty years, he was sure there were things occurring which would be perfectly novel, but they were occurring in the right direction, and he thought India could look forward in the future to a happier state of things than it had ever enjoyed in the past.

Sir Athelstane Baines, C.S I., mentioned that it was under his auspices that Mr. Gait first began census work, and he heartily congratulated that gentleman on the great success with which he had accomplished one of the most difficult tasks in census-taking in the world. Mr. Gait was first brought before his notice by the Chief Commissioner of Assam as a capable district officer, and, therefore, he possessed just the qualifications required for arranging the census preliminaries. Mr. Gait then developed a remarkable taste for statistics, and had acquired a knowledge of scientific works, both in French, German and English, bearing on census work, which had been unrivalled in his (Sir Athelstane's) time in India, and, which he believed was unrivalled at the present day. The work he did in 1901 gave him (Sir Athelstane) full confidence in saying that the census report of 1911 would be far superior to all previous reports. Mr. Gait also had another qualification which was very useful in India. Everyone who took up census work there developed, whether voluntarily or involuntarily, a taste for ethnography. The figures regarding castes and religions that came before one were so replete with interest that even those who began with no taste whatever for the subject were bound to go into it. The only danger was that one might overstep the bounds of ethnography—which came legitimately within the scope of the census—and trespass on the domain of ethnology, which was a very different subject. Mr. Gait had been made Surveyor of Ethnography after the first census, and he had continued his work in that direction ever since, and would carry on the task so splendidly begun by the late Sir Herbert Risley. In the taking of a census, India had one or two great advantages over this country. In the first place there was in India an efficient co-ordination of the official hierarchy. India was exceedingly fortunate in having a more or less permanent agency, or the cadre of an agency, which it could supplement at the time of the census either from official sources or from outside. A second great advantage which India possessed was the comparative immobility of its population. The census of India could not possibly be taken in one night unless what was called the preliminary record was prepared. A record of all the habitual residents in a village or town, or street, or whatever might be the unit of enumeration, was made at varying times from a month to ten days before the census, and on the night of the census that record was brought up to date. Without such a system it would be impossible that 315 million people could be enumerated, even with the assistance of the two million enumerators whom Mr. Gait had

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under his control; it would require fifteen, or even twenty million enumerators to enumerate that number properly *de novo* on the night of the census. The preliminary record was only possible because not more than 5 per cent. of the people would move anywhere out of their habitual residences in the month before the census—and that figure represented the amount of correction necessary to bring the record up to date. A third great advantage which India had over this country in the matter of taking the census, was the number of volunteers. Almost every well-educated person was at the disposal of the local officer, and the tribute which had been paid to them had been well earned. Passing to the results of the census, the figures which had been produced in such an extraordinarily short time were those necessary for immediate and direct administrative purposes. He understood, however, from Mr. Gait that the more elaborate tables were complete, though of course he was not at liberty to publish them until they had been embodied in the report. That was quite a right procedure to follow, because it would be very misleading to publish merely a set of figures in a series of tables. They had to be subjected to very serious examination, and it must be shown where the figures were comparable and where they were not susceptible of comparison with each other or with the figures of other countries. He had seen comparisons instituted between figures for India and figures for some Western countries which were insusceptible of comparison. One of the results of the census, which was of marked importance, was the rate of increase of the population. The rate for ten years in almost every old or settled country ranged from 6 to 8 or 9 per cent. at the most, and he was of the opinion that a moderate rate like 6 per cent. was all that India was likely to get, and all that India was likely to be able to support. Considering that ninety-nine out of every hundred natives of India obtained their subsistence from the cultivation of the soil, a decennial increase of nineteen or twenty millions was as much as India could stand. The question of the density of population must be taken in consideration with the question of occupation. The figure of 175 per square mile given in the paper was a mere arithmetical expression, and was worth nothing statistically. It was not typical of more than a very small area of the country. In India, with its great variety of circumstances between different parts of the country, it was not numerical density that had to be taken into account, but economical density. Mr. Gait had mentioned the possibility of increasing the density per acre by irrigation, but where that was not resorted to, districts with less than 150 per square mile might be economically as congested as districts with three times that population in the more fortunate parts of the country. Referring to the Chairman's question about earlier populations, if he (Sir Athelstane) might be allowed to say so, every surmise and every estimate made about the population before 1840 was not worth printing.

Mr. Bernard Mallet, C.B. (Registrar-General), said, as being responsible for the conduct of the last census of England and Wales, he desired to congratulate Mr. Gait on the splendid success of his vast undertaking. He agreed with Sir Athelstane Baines that India possessed a good many advantages over this country in taking a census, the chief advantage being the command it had over the great administrative machinery. All he (Mr. Mallet) had to call upon was his very small expert staff in his office and two or three thousand registrars and superintendent registrars of births and deaths in the country and any local official he could obtain by going cap in hand to the local authorities. To create organisation under those circumstances was not a very easy matter. Then again apparently India did not have to pay anybody. In this country about two-thirds of the expense of the census was caused by payment to local officers, only one-third being caused by the cost of tabulation. The cost of the 1901 census worked out at about 11*s*. per head in India and about £5 per head in England. He had been attracted by Mr. Gait's remarks as to the superiority of the work done by paid enumerators in India as compared with individual householders in filling up the forms. He thought that remark would probably be true even of a country of comparatively educated people like ourselves. The census officials in this country during the last census had gone as far as they possibly could in the matter of adding questions to the schedule, and they only succeeded by careful process of education through the elementary schools, trades' unions, and the Press in teaching the public how to answer the questions. Some questions—for instance, that about infirmities—really could not be filled up by the public. He himself had been rather anxious to leave out the whole column about infirmities, but the authorities thought otherwise. The figures, however, obtained in that connection were of no use whatever. He was of the opinion that in an ideal system the schedule should be filled up mainly by the enumerators. The idea of having a preliminary record made before the census day by enumerators seemed to be an extremely good one, and he wished such a system could be copied in this country. He was afraid the question of expense would prohibit the idea of following the Indian example in these matters. He had often wondered whether it would be possible by making a great appeal to the public spirit of the country to get people to volunteer to do the work, but he supposed it would not be, after all the past years of paid enumerators. He did not see any other way of improving the usefulness of the census unless the public were willing to pay a good deal more than they did at the present time. One point which had interested him was the adoption of the international scheme of classification. He should much like to know to what extent the list of occupations, drawn chiefly from the French, German and English sources, was adapted to the

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more primitive conditions of India. The classification of occupations in India must be simpler, easier and more satisfactory than in this country, where the sub-divisions of industry were so great as to make it almost impossible to secure an ideal system by which the personal occupation of people in different countries could be compared. The census officials in one respect had followed the excellent example of India in introducing a system of slips or cards, which were tabulated here by machinery. He supposed it was not necessary to use mechanical means in that respect in India on account of labour being so cheap. He could add many instances of errors to those given by Mr. Gait. He certainly had every sympathy with the High Court Judge mentioned in the paper, and indeed, he had to confess, in filling up his own schedule he made a mistake, but luckily he corrected it before it came under official cognisance. One old lady of eighty-six had described her occupation in the words: "Proverbs, chapter xxxi. verse 27." On being looked up, the words were found to be: "She looketh well to the ways of her household and eateth not the bread of idleness."

Sir Thomas Holdich, K.C.M.G., K.C.I.E., proposed a hearty vote of thanks to the author, and on behalf of the Committee thanked Sir Theodore Morison for presiding, and Mr. Anderson for reading the paper. He thought very few people understood what enormous problems vital to the interests of the nation were wrapped up in the pages of a census. For instance, Major Darwin, the President of the Eugenics Society, had recently pointed out the difference in the increase of the undesirable population in this country as compared with that of the desirable or tax-paying classes, from which he argued the decadence of the British nationality. Only when the completed census of India was available would the difference in the percentage of increase between the desirable and the undesirable classes of India be observed.

Sir James Wilson, K.C.S.I., in seconding the resolution, mentioned that he took the census of a district of 250,000 inhabitants in India in 1881, and in 1891 he took the census in another district of 500,000 inhabitants, and it was, therefore, very interesting to him to have all the various incidents which attached to the taking of a census recalled by the paper. He himself was within measurable distance of being a Census Commissioner. In 1901 he had been told that his name had been sent up to the Government of India for that post, but the Government had very wisely appointed Sir Herbert Risley instead. He had received an inkling that afternoon why he had not been selected, as Sir Athelstane Baines had said that for the post of Census Commissioner a man was wanted who did not know anything about mathematics; and perhaps it had been discovered that he had once had some slight knowledge of that subject. He thought all must be impressed by the rapidity with which the last Indian census had been taken. It was a triumph of organisation, and showed what an enormous and far-reaching influence and power the Government in India had when it could enlist the voluntary work of so many people throughout the whole country. That same voluntary effort was available to the Government in India for other things besides taking a census, for instance, in combating famine. It would have been impossible for the Government to have saved the people from starving had it not been for that voluntary aid which had come to its assistance. He hoped to see that help used against the greatest enemy which India appeared to have—not famine, not plague, but malaria—and he trusted the Government would organise such a great campaign against that dread disease that practically the whole of the population would be persuaded to take part in it. There was one very important consideration to which he would like to refer. India had at the present time 315 million inhabitants. That number was increasing rapidly, and how would India support its population one hundred years hence? As far as could be seen the population was likely in time to overtake the means of production, and unless the birth-rate decreased there was a great danger of the general deterioration of the people. That was a question for the future, but it was one which those who were responsible for the government of India should always keep in view.

Mr. J. D. Anderson said he was sure Mr. Gait would wish his mouthpiece not merely to thank his audience for their obvious appreciation of his admirable paper, but also to express his gratitude to the experts, his distinguished predecessors in census work in India, and the Registrar-General, who had commented on what they had just heard. Perhaps, as Sir James Wilson had set the example of indulging in some natural reminiscences of census experiences in India, he (the speaker) might be allowed to add that Mr. Gait's reason for asking him to read his paper was perhaps the fact that, when he was Census Commissioner for Assam in 1891, he (Mr. Anderson) was one of the district officers who supplied him with figures. They once or twice indulged, as brother officers will, in friendly controversy as to details of enumeration, controversy in which the speaker was invariably worsted, and had an opportunity of admiring the powers of organisation which even then distinguished Mr. Gait as an administrator who was bound to make his mark. It was with a mind full of those now ancient controversies that he read his old friend's paper, and it had been a matter of much pride and pleasure to him to be his interpreter. He was glad to think that the interest and importance of this brief account of his great enumeration had been fully appreciated.

The vote of thanks was carried and the meeting terminated.

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SIXTEENTH ORDINARY MEETING.

Wednesday, March 27th, 1912; LORD SANDERSON, G.C.B., K.C.M.G., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Brandon, James Augustine, Battery House, Nepean Sea Road, Bombay, India.

Davidson, Alexander Rae, 150, Stradbrooke-place, Winnipeg, Canada.

Goodenough, Francis William, 1, Young-street, Kensington-square, W.

Groundwater, William, The Rising Sun Petroleum Company, Yokohama, Japan.

Maclachlan, Thomas, Mount Lavinia, near Colombo, Ceylon.

Payne, Harold William, Box 210, Durban, Natal, South Africa.

The following candidates were balloted for and duly elected members of the Society:—

Ba, Maung, Additional Magistrate and Small Cause Judge, Mandalay, Upper Burma.

Brunton, John Robert, 305, Padiham-road, Burnley, Lancashire.

Dass, Bahadur Luchman, c/o B. N. Rutton, Oliver Commercial School, The Mall, Lahore, India.

Finot, Leo, F.R.P.S., 27, New Bond-street, W.

Lichtenstein, Meyer, J.P., Pretoria Club, Pretoria, Transvaal, South Africa.

Okura, Kihachiro, Aoicho Akasaka-ku, Tokyo, Japan.

Sprott, Ernest M., 123, Victoria-street, S.W.

Ward-Thompson, B., Wilpshire, near Blackburn.

Young, Simon J., M.D., Main and Franklin-streets, Valparaiso, Indiana, U.S.A.

The paper read was—

THE WHALING INDUSTRY OF TO-DAY.

By THEODORE E. SALVESEN.

Whaling has been carried on since very early times, but it is only during the last three or four years that the industry, conducted on modern lines, has developed so enormously. I shall endeavour this evening to give as briefly as possible an account of its present position, showing the geographical distribution of the various whaling stations, the methods by which the whales are caught and their products reduced, the various species of whales hunted, and the commercial results of last season's operations in both northern and southern hemispheres.

DISTRIBUTION.

The pursuit of the Greenland Right Whale is now almost neglected, owing to the small catch caused by the scarcity of this species of whale, the most valuable of all the different kinds.

In the eighteenth century no less than 700 vessels, manned by 35,000 men, found employment in hunting the Greenland Right Whale from Spitzbergen to the Davis Straits and Baffin Bay. Now this industry in these waters is conducted by only five barque-rigged wooden auxiliary ice-protected vessels, of from 350 to 450 gross tons. The result of the last few years' operations has been anything but encouraging, and it is not unlikely that the number of this class of whalers will be still further reduced during the coming season, if indeed the industry does not cease altogether.

The Norwegian Sea, lying between the Faroes, Iceland, Jan Mayen and Norway, is annually invaded by about forty-five or fifty vessels, mostly sailers, in pursuit of the Bottle-nosed Whale. The result of last year's catch gave only about 900 tons of oil, which at the present ruling prices will not encourage any expansion of this special industry, which has been a declining one for several years.

In 1866 a whale was first killed by a method quite distinct and different from any known at that time—a method which will be fully described later on. The success attending the new method led to the formation of a great number of Norwegian whaling companies on the north coast of Norway, in the Finmarken district, as many as thirty-four steam whalers being employed in 1885 with a catch of about 1,000 whales. This industry came to an end in 1905, the prosecution of the whaling industry in the north of Norway having been prohibited by law at that time.

In Iceland the whaling was started about thirty years ago, and the industry is now carried on by two companies operating on the north-west coast with eight steam whalers, and by four companies on the east coast employing nineteen whalers. The results of the operations off the coast of Iceland have been unsatisfactory during the last few years, and consequently the industry will be conducted with fewer craft in the coming season.

At Spitzbergen there are two companies working, one with two whalers and the other with four. The season is a very short one, owing to the ice conditions, and the extension of whaling operations here is not looked for.

Off the Faroe Islands whaling has been

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carried on for many years with varying success. Last year there were six companies operating with fifteen steam whalers, but this number will be decreased in the coming season.

Whaling off Shetland was commenced in 1903, and off the Hebrides in 1904. There are in all five companies interested, operating eleven steam whalers.

In 1909 the coast off the west of Ireland was invaded, with such satisfactory results that two whaling stations have been erected with licences to employ five whaling vessels. The experiences, however, of the last two seasons have been so unsatisfactory that no further development of these whaling grounds can be looked for.

Crossing the Atlantic to the Newfoundland coast we find only five whalers operating—all that is left of a large fleet which, started in 1899, flourished for only a few years, and gradually ceased to be anything but a negligible quantity over five years ago, when most of the whalers were sold to the Japanese.

The St. Lawrence River whaling was revived last year by a Norwegian-Canadian company, but the results of the first year's operations have not been satisfactory.

A specially constructed steam whaler was sent into the Davis Straits last season with orders to pursue the Right Whale and also the Finner species. Only twenty-four Finner Whales were captured, a result which will probably not lead to a continuance of this experiment.

I have now enumerated all the whaling operations carried on at the present time in the North Atlantic and Arctic Seas.

In the North Pacific there are still a number of barque-rigged, ice-protected wooden whalers which belong to San Francisco, and which pursue the Right Whale in the Behring Sea and neighbourhood. New Bedford seems also to have about twenty-seven of the old-fashioned vessels still surviving, but these, I understand, are principally employed south of the Equator hunting the Southern Right Whale and the Cachalot.

In 1840 we read that no less than 827 vessels were engaged in this industry, which number was reduced to about 160 in 1875, and since then has constantly been on the decline.

Off the coast of British Columbia the industry is being carried on with great vigour by ten modern whalers, which number during the coming season may be increased. The seas off these shores have proved themselves to be well stocked with the Finner variety of whales, and the business has been of so lucrative a nature that two or three new companies have been formed to commence during the next season, and to operate on a large scale, off the coast and islands of Alaska. These companies will fly the flag of the United States, whereby the products will be admitted to that country on preferential terms.

Before leaving the northern hemisphere, I have still to mention the Japanese whaling industry carried on under such protective conditions that all the crews, except some of the gunners, are Japanese, and the capital employed is wholly Japanese, the industry at present being conducted from twelve shore stations operating twenty-eight modern steam whalers. Little oil is exported, as the greater part of the carcasses is used for human food in Japan and the adjacent Korea.

A Norwegian enterprise, under the Russian flag, made experimental cruises from Vladivostok last season, fishing in the Sea of Okhotsk, and in the Behring Sea, but the results have not been satisfactory, only six whales having been secured.

This brings me to the end of the whaling enterprises in the northern hemisphere. It will be noticed that the industry is on the decline, except so far as the North Pacific Ocean is concerned, where there seem to be probabilities of favourable expansion.

The great increase in the whaling industry has come from the southern hemisphere, and I shall start from the Island of South Georgia, where it was first initiated about eight years ago. The whaling grounds of this small island in the South Atlantic have so far shown themselves to be the most lucrative ever discovered. At present there are in operation eight companies, working twenty-one whaling steamers. At the South Shetlands and Graham Land ten licences have been granted by the British Government for thirty steam whalers. In the Falkland Islands a British company operates five whalers. In the south of Chili in the Magellan Straits, one company has its station and factory, and two others are situated on the west coast of Chili. Another company has been formed to operate at Corral, and during the off season there the business will be carried on from the Galapagos Islands. The Kerguelen Whaling Company has its seat on the island of the same name, but its efforts so far have not been crowned with success in the whaling line, not owing to want of whales so much as to constant stormy weather conditions, during which it is impossible to carry on the hunt.

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The whaling season at these South Atlantic stations closes about the month of May, by which time most of the whales have proceeded northwards into the warmer waters, and they are found in large quantities on the coasts of the continents of South America, South Africa, Australia, and New Zealand.

African whaling was started about four years ago in Durban, and the success was so striking that a great many companies have since been formed to share in the industry. Taking the west coast of Africa first, we have companies operating at Lobita, three in Elephant Bay, one in Mossamedes (a Portuguese company), one in Port Alexander, and one in Tiger Bay, all in Portuguese West Africa. Coming further south, concessions have been granted for Walfisch Bay, and probably whaling will be commenced there during the coming season. Two companies work from Saldanha Bay, one from Mossel Bay, on the south coast, and three from Durban. One station has been built at Inhambane in the Mozambique Channel, and another company operates at Angoche, the two latter being in Portuguese East Africa. Altogether thirty whalers were employed off South Africa, but during the coming season this number will be greatly augmented.

On the east coast of South America, so far, the whaling grounds round Bahia have only been tapped, but as the experiment proved successful one or two more companies are being formed to work with the neighbourhood of Bahia as their base.

Australia and New Zealand have only been tried experimentally, but the prospects seem to be so favourable that already several large ventures have been started in order to exploit the possibilities of the waters round the Australian continent, Tasmania, New Zealand, and other islands.

Methods.

So much for the geographical distribution of whaling stations. Let us now consider the way in which the animals are taken. Until the year 1866, the method of killing whales was either by throwing by hand, or by shooting from a gun or cannon, a harpoon with or without a bomb, and attached to a line. This was performed from the bow of a rowing boat, and if the whale was not killed outright by the first harpoon, which hardly ever happened, more harpoons were buried in the whale's body, shot there from the first boat or from others belonging to the same vessel, until the animal eventually was killed. As has been stated, the only species of whales which were pursued and killed up till 1866 were the Right Whale and the Cachalot, the reason for this being that these whales, when dead, float. The Finner Whales, on the other hand, sink when they are killed, and as their weight is considerably greater than the buoyancy of a whaling boat, it is impossible to secure them by a line from a rowing boat, as if one were to hold on to the whale line the inevitable result would be that the boat would be hauled under the surface of the sea. The Finner species are also much more active than the Right Whale and Cachalot, and seldom remain long enough at the surface to permit a rowing boat to approach them.

A Norwegian, Svend Foyn, was the first to solve the difficulty of how to kill and secure the large Finner Whales, and the methods introduced by him are now, with considerable improvements, those in use at the present time in all the modern whaling steamers. The most approved type of such a vessel is from 100 ft. to 115 ft. long, with a breadth of from 18 ft. to 21 ft. 6 ins., decked all over, and cut away at the bow and stern in order to make the vessel answer her helm quickly (Fig. 1). The lines of the hull are designed for a speed of from eleven to twelve knots, and the engines are of 350 to 650 effective horse-power. She is fitted with a glycerine recoil cannon, with a bore of about $3\frac{1}{2}$ ins. in diameter, and about 45 ins. in length (Fig. 2). The cannon is fixed on a swivel in the bow, and when loaded with powder and harpoon is so delicately balanced that the gunner can raise, and lower, and turn it from side to side, without any apparent exertion. The harpoon is of finest Swedish steel, and is about 6 ft. in length with a weight of a little over 1 cwt. It has four prongs, which spring out at right angles to the harpoon when the line is tightened after the harpoon is lodged in the whale's body. On the top of the harpoon is screwed a cast-iron head or shell, of conical shape, about 14 ins. in length and weighing about 11 lbs. This shell is charged with gunpowder and a time fuse usually explodes it three seconds after the harpoon has left the cannon. A 4 in., $4\frac{1}{4}$ in., or $4\frac{1}{2}$ in. foregoer, sixty fathoms in length, and made of the finest Italian hemp procurable, is attached to the harpoon, and to the other end of the foregoer a 5 in., $5\frac{1}{4}$ in., or $5\frac{1}{2}$ in. whale line of 120 fathoms is spliced on. If required, additional lines may be attached. There is a double set of lines on each boat, one on the starboard side and one on the port side, and the lines are most carefully coiled down in suitable bins under deck. A

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Fig. 1.—Modern Steam Whaler.
In the foreground two Finner Whales are being towed to the factory slip.

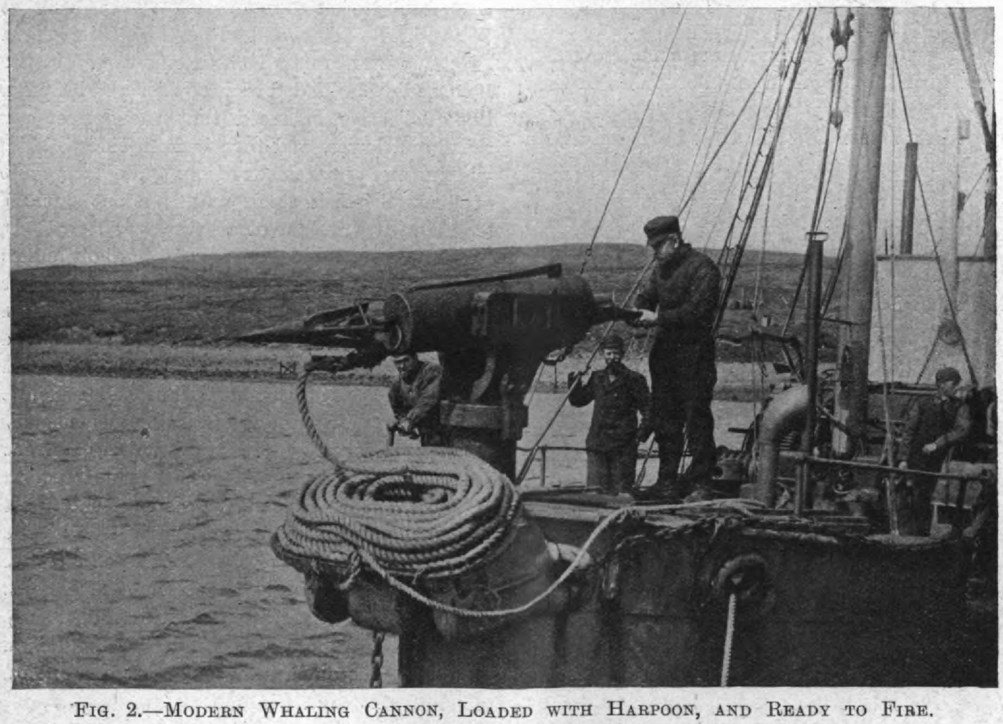

Fig. 2.—Modern Whaling Cannon, Loaded with Harpoon, and Ready to Fire.
(The photographs are by Mr. R. H. Ramsay, of Lerwick.)

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large double whaling winch is fixed abaft the mast, with engines having cylinders of from 6 ins. to 7 ins. in diameter. Along the keelson from forward to the boiler bulkhead, are arranged double rows of steel springs connected to two snatch-blocks above the shrouds of the foremast by strong flexible steel-wire rope.

The whale is usually sighted by a look-out in the crow's nest on the mast. The steamer is then sent off in the direction of the spot where the whale was seen, but long before this is reached the whale has sounded, and the whaler moves towards the vicinity where it is expected that the animal will rise to breathe.

Gradually the distance separating the hunter from the hunted is lessened until the gunner gets within range, which is anything from about fifteen to twenty yards. The chase may go on for hours, and it often happens that the whale entirely disappears from sight and gives no chance at all for a shot. If the whale is killed outright the animal sinks, drawing with it the whale line paid over the drums of the winch. The steamer is brought to a standstill, and when the line hangs vertically it is stoppered in the bow, and the inboard part is passed into one of the snatch-blocks at the shrouds, and then round the drums of the winch, by which the whale is raised to the surface.

The object of the steel springs arranged in the bottom of the vessel is to compensate for the rise and fall of the whaler, caused by the wave motion when the whale is attached to her, and consequently these steel springs should be compressible to an extent equal to the difference between the top and the bottom of the waves. Were no accumulators, as these springs are called, provided, the strain on the rope when heaving in the whale, caused by the rise and fall of the steamer, would be greater than the strength of the line, which would consequently break, and rope, harpoon, and whale would be lost. If the whale is not shot dead on the spot, the gunner has to play it, in a very similar manner to that of the angler who has hooked a salmon. In both cases the strength of the line is very much less than the power at its extremity, and most experienced skill and care in handling have to be exercised. The whaling steamer plays the whale by manipulating the steam winch and also by moving ahead and astern, but it often happens that the line will be snapped by a sudden jerk, or a leap above the surface of the water. The whale having been raised to the surface, a chain is passed round the tail inside the flukes, and made fast at the bow ot the ship, the harpoon line is cut off at the harpoon, and the whale is towed at the side of the vessel, tail foremost. In order to make the carcass float, and to lessen its towing weight, a hole is pierced through the body into the lungs or stomach, and the whale is inflated with air by a steam air-pump in the engine-room of the whaler. If the conditions are favourable the hunt is continued until dusk, when the steamer usually heads for the reducing station to hand over the carcasses to the factory. She then steams off again as soon as possible, the object being to arrive at the whaling grounds by sunrise of the next morning.

In northern latitudes it is seldom that more than four whales are brought in during one day, but in the south, where they are much more abundant, eight to ten whales per day is not an unfrequent occurrence for one whaling steamer.

This is the method of killing and taking whales employed by all modern whaling companies. Killing and taking whales by means of rowing boats is only practised by the old-fashioned Dundee, San Francisco, and New Bedford whalers, and by the fleet of small vessels which pursue the Bottle-nosed Whale.

Reduction.

The vessels carrying on the pursuit of the Right Whale and Cachalot are constructed so as to receive the products of their catch; thus the whalebone is cut out and stowed away, and the blubber is flensed off the whale and deposited in tanks on board the whaler and discharged at her home port, where it is tried in. The American Cachalot whalers boil down the oil on the high seas.

With the modern whaler, a factory is an essential part of the equipment. These factories are of two kinds—a shore factory and a floating factory. A complete shore factory consists of plant which reduces every part of the whale carcass to merchantable products.

Nearly all the whaling stations and factories in the northern hemisphere are complete, but in the south there are comparatively few stations which do more than boil down the blubber of the whale. The distance from the markets, with the consequent expense of bringing to the factory the stores necessary for reducing the carcass and the extra freightage incurred in conveying the finished products to the markets, make it questionable whether it is a profitable business to reduce more than the blubber in such places as the South Atlantic; indeed, the work can only be conducted under any circumstances when the products are saleable at high prices.

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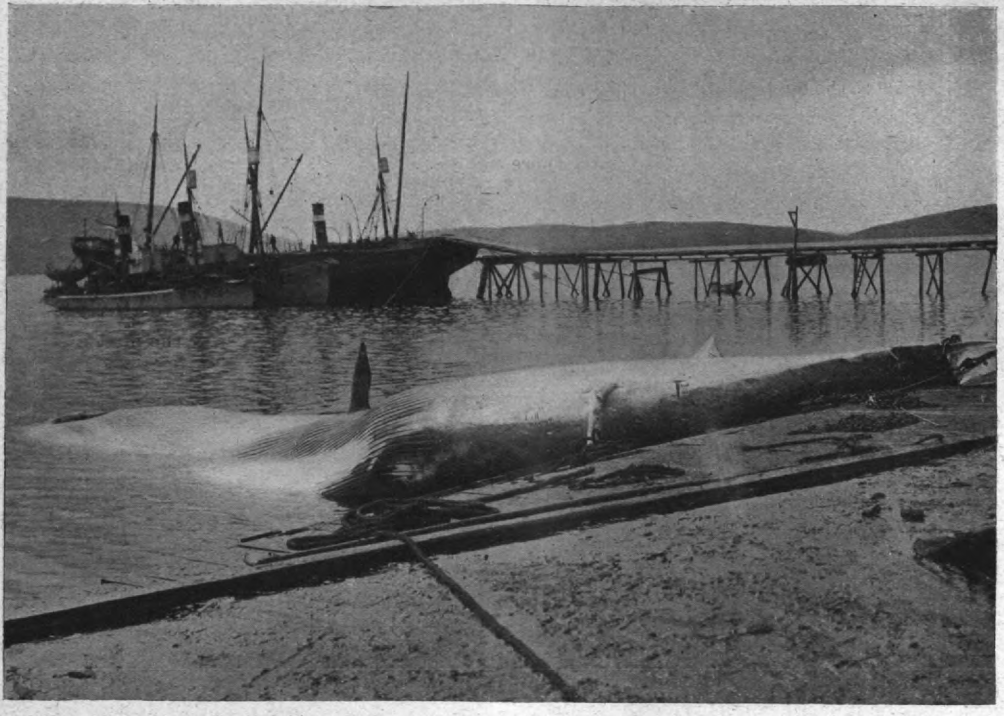

FIG. 3.—WHALE BEING PULLED UP THE SLIP ON TO THE FLENSING PLATFORM.
Three whaling steamers, moored to a coal-hulk, are seen in the background.

FIG. 4.—FLENSING A FINNER WHALE—THE FIRST CUT.

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If the whale be brought to a fully-equipped shore factory, it is hauled up a slip on to the flensing platform (Figs. 3 and 4), where the whalebone or finners (as the baleen of the Finner species of whale is commonly called) are removed, the blubber cut off in strips, chopped into small pieces, and conveyed to large open vats, where the oil is extracted by means of direct steam. In Newfoundland and British Columbia the oil is usually extracted by the benzine process, but although the resultant quantities seem to be greater, the treated oil generally fetches a lower price. The tongue and kidney fat are treated similarly, but the flensed carcass has to be chopped and sawn into suitable pieces and then conveyed into large boilers, where the contents are subjected to a steam pressure of about 60 lbs. per square inch for twelve to fifteen hours continuously. During this period the oil contained in the carcass is run off into tanks. The digesters thereafter are emptied of their contents, which are passed over large open drying kilns, fired by foundry coke, and finally the dried residue is run through a disintegrator, then sifted, and finally bagged as a fine powder or meal.

Three products may be obtained from the dried meat and bones: Firstly, whale meat meal made exclusively from absolutely fresh whale flesh, the best parts only being used; this is a most nutritious and wholesome foodstuff, containing about 79 per cent. of protein. Secondly, whale guano, made from the carcass, flesh, and about one-third of bones; the analyses of this shows about 8·50 per cent. ammonia and about 21 per cent. of tribasic phosphates of lime. Thirdly, bone meal, yielding about 4 per cent. ammonia and about 50 per cent. phosphates. The whole of the dried carcass may also be made into one product, making a rich guano of great value, and containing from about 10 to 11·75 per cent. ammonia and 17 to 23 per cent. of phosphates. The present value is about 11*s.* 6*d.* per unit of ammonia, and 9*d.* per unit of phosphates.

The value of whalebone, baleen or finners, varies greatly. The product of the Greenland Right Whale is the most valuable, but the present market price can hardly be stated at more than about £1,200 to £1,500 per ton. The baleen of the southern Right Whale and the Biscay Whale is worth from £800 to £1,000 per ton, whereas the finners of the Fish Whale (*borealis*) is only about £65, Blue Whale and Finner Whale about £50, and of the Hump-backed about £25 to £27 10*s.* per ton. Very few finners of the low-priced qualities are shipped from the South Atlantic stations, as it has been demonstrated that the cost of preparing and placing them on the market is barely more than what the goods realise.

Whale oil is usually graded into four qualities: Nos. 1, 2, 3 and 4, although some companies add a fifth—No. 0. Nos. 0 and 1 are made entirely from the blubber; No. 2 from the tongue and kidney fat and from the residue of the blubber boilings; No. 3 from the flesh and bones; and No. 4 from refuse.

During last season the demand was great, and prices ruled in consequence high—£24 to £25 per ton, barrels included, being obtained for the best qualities, with from £1 to £2 per ton reduction between the grades. The prices ruling this year are very much lower, in sympathy with the values of competing seed oils.

Where circumstances, climatic or otherwise, make the erection of a shore station and factory difficult or costly, or where, owing to ice setting in, the season is a very short one, floating whaling factories are now utilised. These consist of a steamer varying from 3,000 to 8,000 tons dead weight, provided with all the necessary reducing plant, and with tanks for storing the oil. The whales are flensed in the water alongside the vessel, and the blubber hoisted on board, where it is treated in a similar manner to that adopted in the shore station. These floating factories are complete in themselves, and accommodate the whole of the crews necessary for the operations conducted, which vary from fifty to 100 hands, according to the size of the vessel and the plant fitted on board.

The power of reduction of the best-fitted floating factories is very considerable, as it is no unusual thing to dispose of twenty whales per day. Some vessels have plant fitted, not only to dry the blubber, but also to reduce the flensed carcasses, and several companies have one floating factory for boiling down the blubber alone and another which deals only with the flensed carcasses. In this way the whole carcass is utilised.

Experiments have also been made with the fitting of guano-drying plant afloat, but so far the efforts have been unsuccessful, and it is doubtful whether the expenses of reduction and marketing will be covered by the price realised for the finished products.

Species.

According to Guldberg, a Norwegian professor, there are between 140 and 160 different

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species of whales, but the following are those of commercial value :—

The Greenland Right Whale (*Balaena mysticetus*) attains a length of about 60 ft., and has a very large head, about one-third of its length. The whalebone has a length of up to 15 ft., 300 to 400 pieces on each side, which command the highest prices on the market, owing to the length and quality. This is a purely Arctic species.

The Nordkaper Whale, or Biscay Right Whale (*Balaena biscayensis*), is somewhat smaller than the Greenland Right Whale, and has not such a large head. The whalebone is of a similar quality to that of the Greenland Right Whale, but the length is seldom more than 7 ft. It is most frequently found in the North Atlantic, off Ireland and the Hebrides, but specimens have also been secured off Shetland, Faroe and Iceland.

The Southern Right Whale (*Balaena australis*) is an Antarctic species, and has a length of about 45 ft. to 50 ft., and whalebone measuring up to about 7 ft. in length.

The White Whale (*Delphinapterus leocas*) is absolutely white and about 20 ft. in length. It is furnished with teeth in both the upper and lower jaws. It is a purely Arctic whale.

The Bottle-nosed Whale (*Balaenoptera hyperoodon*) has a length of about 20 ft. to 25 ft. It is principally found in the Norwegian Sea from April to July.

The Cachalot or Sperm Whale (*Physeter macrocephalus*) has a length of about 50 ft. to 60 ft., and is found on both sides of the Equator, but has also been killed in the temperate and cold zones as far as Iceland in the north and South Georgia in the south. It has an unusually large head, and teeth in the lower jaw only. In its head is found the valuable spermacetti and sperm oil. As much as ten tons may often be collected from a single whale.

The Blue Whale (*Balaenoptera sibbaldii*) is the largest living animal in the world, and attains a length of up to about 100 ft. It is found in almost all seas. The whalebone or finners are seldom more than about 3 ft. in length.

The Finner Whale (*Balaenoptera musculus*) has a length of about 70 ft. It is also found in most seas all over the world.

The Humpbacked Whale (*Megaptera boops*) is about 50 ft. in length, and has a large head, with a flat forehead. The body is short and thick. It is found nearly all over the world, more especially in the South Atlantic, from November to May, and off the coasts of South Africa and South America, and probably also off the Australian continent, from May to November.

The Fish Whale (*Balaenoptera borealis*) is usually about 40 ft. to 50 ft. in length, and is principally captured off Scotland and the Faroe Islands, in the north, and the Falkland Islands in the south. It is a whale of very small value, and is only pursued when there is a scarcity of the larger species.

Production.

During the season of 1911 there were in operation north of the Equator, about 120 modern steam whaling vessels, and the catch was about 5,000 whales, yielding about 156,000 barrels of oil of about 26,000 tons. These figures are exclusive of the Japanese fleet. The approximate value is about £625,000. Compare this with last year's result of the whalers operating at South Georgia alone. Here, with only nineteen whalers, 7,000 whales were brought in, yielding about 200,000 barrels of oil, or about 50 per cent. more whales, and nearly 40 per cent. more oil than the total result of the combined efforts of the whole whaling fleet operating in the northern hemisphere.

In the South Shetlands, twenty-two whalers bagged 3,500 whales, yielding 100,000 barrels, and South Africa's thirty whalers accounted for 4,000 whales, giving 120,000 barrels. Altogether the total catch of the eighty-six steam whalers operating in the southern hemisphere was about 17,500 whales, yielding about 500,000 barrels of oil, representing a gross value of about £1,750,000. The total value of the catch of the whaling industry for last season, excluding the Dundee, New Bedford and San Francisco, and bottle-nosed vessels, thus amounts to about £2,375,000, and from all sources may be estimated as worth between two and a half and two and three quarter million pounds sterling. The total number of whales killed was about 22,500, yielding about 620,000 barrels, or about 103,000 tons of whale oil, which constitutes a world's record, and is nearly twice as large as the catch of the season 1910. The present season is expected to eclipse its predecessor by at least 10 to 15 per cent.

The industry gives employment to about 10,000 men, manning the whaling vessels and working at the factories ashore and afloat. Of these, by far the greatest number are Norwegians, and it is they who have started all the whaling enterprises in the different parts of the world working on modern lines.

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DISCUSSION.

THE CHAIRMAN said he was not qualified to speak on the subject of the paper, beyond the fact that he had been brought up in the nursery on a charming book called "Peter the Whaler," and he was afraid any remarks he made could be tendered by any person in the room. He thought everybody must have been struck while the author had been reading the paper by the amount of energy, ingenuity and resourcefulness which had been displayed by the Norwegians in the whaling industry: they seemed to have pervaded the whole of the world in their search of the whale. He recollected hearing the late Lord Granville once saying that a celebrated sportsman had told him that he had pursued every possible kind of sport, and had speculated on the Stock Exchange, but that he had never known what continuous excitement really was like until he began to manage his own farm. He (Lord Sanderson) thought the audience would agree with him that if that gentleman had gone whaling in the manner which had just been depicted on the screen, he would have experienced entirely new sensations. There was one point on which the author had not touched, as only the practical side of the question had been dealt with in the paper, and that was whether a whale was really a fish. When he (Lord Sanderson) was engaged on the Behring Sea Commission, he went to hear a lecture by Sir William Flower upon seals, and the first thing that gentleman did was to draw upon the blackboard the skeleton of a squirrel and then to surround it with the outside of a seal; and he (Lord Sanderson) believed that the whale was the skeleton of a mammal with some very undeveloped hind legs. He supposed that made it, none the less, a fish to most people, although from a zoological standpoint it was not a fish. The remark made in the paper with regard to the falling off in the northern whale fishery and the immense increase in the southern whale fishery, reminded him of a walk he once took near Dungeness. He came across a coastguardsman with an enormous telescope, who was reflecting upon shrimps, and the man remarked that when he was a little boy he was able in half an hour to get quite enough shrimps for his tea, but in consequence of the number of people now engaged in shrimping operations, and the deadly nature of the instruments employed, it took him the whole afternoon to get sufficient to feed a single infant. The man finished by saying that whatever man enjoyed, that man destroyed. He (Lord Sanderson) could not help thinking that similarly some kind of precaution ought to be taken that the whaling industry should not exhaust itself by its own efforts.

MR. BULLEN, referring to the author's phrase "old-fashioned whaling," said that no doubt operations in the past had been old-fashioned, and certainly the industry had been a very poorly paid one. He sincerely trusted that the men seen in the pictures thrown on the screen were a great deal better paid than he had been. The author was quite correct in saying that the old whaler had the advantages of not having to seek permission to hunt whales, that he was a pelagic fellow, that he went outside the three-mile limit, and so on, but he (the speaker) could very well remember being surrounded by at least three thousand sperm whales, and having to be satisfied with one, which, when they got it, took a fortnight to dispose of. Nothing could be done to it until the wind was favourable enough for the ship to get into port, and when they had stripped all the blubber they possibly could off it, the Maoris got hold of the carcass——which, perforce, had had to be cut adrift—and succeeded in getting many more pounds' worth of oil out of it. He joined issue with the author in regard to the character of the weapons that were used. The Cachalot was as huge and as hardy a creature as could be found in the ocean, and yet he had on four occasions seen a Cachalot killed within the space of three minutes by a thrust from a hand lance delivered by an experienced man. Such a man was not even in these days to be despised, because the author himself had confessed to having followed a whale for seven or eight hours before one of those tremendous 6-foot harpoons with its 11 lbs. of gunpowder to blow the whale's inside out could be planted in the whale's body. Two years ago he was on the coast of Bahia going to Buenos Ayres, and he saw something like 25,000 whales; the ocean was covered with them, and the only people engaged in hunting them were those people of which the author spoke, and justly, with a tinge of scorn, the natives of the Brazilian coast—who, he thought, were born tired, and whose only ambition seemed to be to prevent anybody else from doing work which they would not do themselves. He understoood that state of affairs was going to be altered in the future. He thought he could safely voice the opinion of the audience in thanking the author very warmly for his paper. In conclusion, he would warn the southern whalers that they had better make hay while the sun shone, as if seven whalers were getting 7,000 whales in one spot, it would not be very long before the southern whale fishery would follow the northern whale fishery, and the whales would practically disappear from the sea.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

DISTRESSED INDIAN STUDENTS' AID COMMITTEE.

The first annual report of this Committee, which has just been issued, affords some interesting reading. The Committee, which is under the chairmanship of Sir James Wilson, K.C.S.I., with offices at the Indian Students' Centre, 21, Cromwell

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Road, S.W., was formed for the purpose of collecting, receiving and distributing money given in private charity, or from public funds, for the benefit of Indian students in pecuniary difficulties in this country.

The objects of the Committee are:—(1) To assist deserving cases of temporary distress; (2) In case of remittances being delayed, to help the applicant with a loan; (3) to help students who have no means of subsistence in this country to return to their own homes; (4) to obtain the repayment of advances made or other necessary funds from the student's relations or friends in India; (5) to save charitable persons in this country from being imposed upon by undeserving applicants.

At present there are believed to be in this country about 1,700 Indian students, of whom some 1,000 are working in London. During the past year the Committee dealt with applications from thirty-eight Indians of various castes and creeds belonging to different Provinces and Native States.

The report contains a paragraph relating to the cost of study in Europe and the equipment that should be possessed by an Indian student before deciding to come to this country, which deserves to be quoted in full:—

"Our experience of the distressing cases with which we have had to deal leads us to urge earnestly on all parents in India, and on others having influence over young Indians who may think of coming to this country to study, the duty incumbent on them of discouraging any student from carrying out such an intention until full provision has been made for the expenses he must necessarily incur in order to obtain any real advantage from his stay in England. It is hardly possible for an Indian student to complete a course of education in this country, and to obtain a call to the Bar, or a degree or diploma which will be of any use to him in after life, at a cost for passage, fees, clothes, books, board and lodging of less than Rs. 10,000, and no Indian parent should allow his son to come to England for study unless he can see his way to provide this sum without unduly crippling his own resources. Many students cost their families Rs. 12,000 or Rs. 15,000, and it would be wise to count on the possibility of having to provide as much as this. It is also of great importance that no Indian student should leave India for England until he has acquired a thorough knowledge of English and a good general education, and if possible a degree of an Indian university. While the majority of Indian students here are diligent and well-behaved, and make a good use of their time, and go back to India with a more thorough knowledge and wider views, we have met with too many cases in which it is obvious that the youth should not have been allowed to come to this country at all, and that he will ultimately have to return to India a failure, after having cost his family much more than they could spare, and having possibly himself, owing to imperfect education or insufficient pecuniary resources, become degraded, instead of improved, in character. The Committee will be glad if, in consequence of their labours, such cases become fewer in number, to the advantage of the young men themselves, of their families, and of the whole body of Indian students."

EXHIBITION OF OLD MASTERS AT NICE.

A collection of works of the old painters of the Nicene school, "Les primitifs Niçois," is being shown by the Société des Beaux Arts of Nice. These paintings, which occupy several rooms at the Municipal Museum, are interesting specimens of local art of the fourteenth and fifteenth centuries. The collection consists chiefly of altar-pieces, tryptichs and panels lent by the owners, and in many cases the paintings are remarkable for the intense religious feeling which must have inspired their authors. Many of these works were discovered in the churches, monasteries and shrines, in out-of-the-way mountain villages or in the small towns in the Maritime Alps. Two rooms are devoted to tracings from frescoes. Those from the chapel of St. Maur at Saint-Etienne-de-Tinée, representing the martyrdom of St. Sebastian, and another of the martyrdom of St. Bernard, from Venanson, painted in 1480, may be noted as especially bold in treatment. A fresco by Canavasi, painted in the middle of the fifteenth century, from the chapel of St. Sebastian at La Tinée, and many others including the works of Gaspard Nadal and Currandi Brévisi in 1493, from the chapel of La Tour, are remarkable for their purity of style and treatment.

A third room contains a number of paintings lent by the Principality of Monaco, consisting chiefly of altar-pieces.

Especially worthy of attention is "The Descent from the Cross," by Lodovico Bréa, painted in 1505. This is surrounded by six panels representing various scenes in the Passion of Christ. Two other panels representing St. John the Baptist and St. Vincent, by an unknown painter, are remarkable for their harmonious colouring.

The great altar-piece belonging to the church of St. Nicolas, painted by Lodovico Bréa in 1500, in which the patron saint occupies the centre panel, and St. Michael and St. Madeleine with other saints on a background of gold the sides, is well worth attention.

Another altar-piece, from the Church of the White Penitents at Monaco, is interesting on account of a landscape showing La Condamine as it appeared in 1520.

Amongst the gems in this collection worthy of note, must be mentioned the altar-piece in five compartments from Bouyon, another from Vence, painted in 1450 by Jacques de Carolis, representing

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Journal of the Royal Society of Arts.

No. 3,098. VOL. LX.

FRIDAY, APRIL 5, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CANTOR LECTURE.

On Monday evening, April 1st, Mr. Noel Heaton delivered the third and final lecture of his course on "Materials and Methods of Decorative Painting."

On the motion of the Chairman a vote of thanks was accorded to Mr. Heaton for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

VII.—The Officials. The Transactions. The Council. The Charter. (1761–1847.)

On the death of Lord Folkestone in 1761, Lord Romney was elected President, and he held the office till his own death in 1793. From its foundation, he had always taken the greatest interest in the Society, and during his presidency he continued to attend regularly. There is no doubt that the Society owed a great deal of its early success to its first two presidents.

During Lord Romney's presidency a proposal was made that the Prince of Wales should be elected patron, and His Royal Highness seems to have agreed. At the meeting of the Society on December 14th, 1785, a letter was read from Caleb Whitefoord,† saying that the Prince would become patron, and the proposal was approved. However, at the meeting of the following week (December 21st) other counsels prevailed, and the consideration of the question was "postponed," not to be revived. The reasons for this action are veiled in what was perhaps a judicious reticence.

Lord Romney died in November, 1793, and was succeeded in the following year by the Duke of Norfolk. The Duke had been elected a member of the Society in May, 1769, as Charles Howard, jun., his father, also Charles Howard, having become a member in 1758. The elder Howard became tenth Duke of Norfolk in 1777, when his son became Earl of Surrey. The tenth Duke died in 1786, when he was succeeded by his son as eleventh Duke. He was made a Vice-President in 1791, and was elected President at the election of officers in 1794.

He was a man of considerable natural ability and of independent character. He was distinctly eccentric, and was a frequent subject for Gillray's caricatures. Slovenly in his habits and dress, and too much addicted to conviviality, he was yet a liberal patron of literature and the arts, a ready speaker, and endowed with plenty of common sense. He was extremely popular, especially in Cumberland, and in the borough of Carlisle, which he represented for some time in Parliament. But he lacked self-control, and allowed himself a licence in speech and behaviour for which only his great rank procured toleration. He insulted the King, and was deprived of certain of his commissions. At

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, November 3rd, 1911, and January 12th, 19th and 26th, 1912.

† Caleb Whitefoord was for long a prominent member of the Society. He was a friend of Franklin, being his neighbour in Craven Street, and was proposed by him in January, 1762. He continued a member till his death in 1810. He was then a Vice-President, having been elected in 1800, and for many years, from 1786 onwards, he served as Chairman of the Committee of Polite Arts. He was Secretary to the Commission which concluded peace with America in 1781, but had a greater reputation as a wit than as a diplomatist. Burke described him as nothing more than a *diseur de bons mots*, but he was well known and popular in Society. He was a friend of Johnson, Goldsmith, Garrick and Foote. The Society possesses a portrait of him painted by an unknown artist, and another portrait, engraved by Holl from a painting by Stuart, forms the frontispiece of Vol. XXIX. of the *Transactions*. He presented Templeman's portrait to the Society, and was also instrumental in obtaining the portrait of Shipley. A short memoir of him is included in the preface to the volume of the *Transactions* above mentioned.

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one time he was intimate with the Prince of Wales, but they quarrelled. Their reconciliation was celebrated by the disgraceful practical joke played upon the Duke in his old age by the Prince, and described in scathing language by Thackeray in the "Four Georges." The Duke, himself a sufficiently seasoned toper, was invited from Arundel to the Pavilion at Brighton, and there made most disgracefully drunk. Readers of Thackeray's brilliant, but very one-sided, essays will remember the sorry story well enough.

He certainly did not take the same keen personal interest in the Society's welfare as did his two predecessors, but he made a good and attentive President, and at all events performed efficiently the ceremonial functions of his office. He attended regularly at the annual distribution of prizes, and occasionally at other meetings when important business had to be transacted. It was owing to the Duke's objection to the proposal that the resolution giving permission to Barry in 1801 to substitute portraits of King George III. and Queen Caroline for those of Lords Folkestone and Romney, then in the Great Room, was rescinded.*

The Duke of Norfolk died in December, 1815, and his death was formally reported at the ordinary meeting of the Society on the 20th of that month. At the next meeting, on January 10th, 1816, it was proposed that the Duke of Sussex should be nominated in his stead. His Grace was a member of some four years standing, he having been elected in April, 1811, when he paid the usual life membership fee of £21. An extraordinary meeting was called for February 1st, and His Royal Highness was elected by 180 votes to twenty-four over the Earl of Liverpool, who had also been proposed. At the same meeting a deputation was appointed to wait on the Duke and to invite him to accept the presidency. The deputation was received at Kensington Palace on the twelfth of the same month. The Duke made a very courteous and complimentary reply to the elaborate address presented by the deputation, and accepted the office, apparently with some gratification. He attended the next meeting of the Society two days later (February 12th, 1816), was duly inducted into the chair, and conducted the regular business of the meeting.

The sixth son of George III., the Duke of Sussex was a man of liberal sentiments, genial manners and intellectual tastes. He took a genuine interest in art and in science, and was well qualified for such a post as the presidency. He liked the work, and did it well, and enjoyed acting as figure-head on all ceremonial occasions. Afterwards (from 1830 to 1839) he acted as President of the Royal Society, and in both offices he made himself popular. That he should take any active share in the management of either society was not to be expected, but he was always ready to attend any functions which required his presence, and discharged the duties required on such occasions with unvarying amiability and dignity.

So far as the Society of Arts was concerned, the most important functions for its President were the annual dinner and the annual distribution of premiums. The latter ceremonial was for many years held in the Society's own room, but the attendance grew too large for the limited accommodation, and after a good deal of consideration, when it became clear, after several years' experience of inconvenient crowding, that the meeting-room was too small for the numbers attending, a move was made in 1816 to Freemasons' Hall. In 1820 the distribution was held in the Argyll Rooms,* and in 1822, as the crowds still grew, Drury Lane Theatre was hired for the occasion. It is clear that the event had become an important social function. There was a military band, a body of stewards was organised, and a staff of policemen engaged. Altogether it was a very important ceremonial, requiring not a little fuss and organisation. The secretary was required to deliver an appropriate address—two of Aikin's are printed in the *Transactions*.

For some years these celebrations were continued at Drury Lane or at the King's Theatre,† but in 1829, either the attractions of the ceremony had diminished, or the diminishing funds of the Society rendered economy desirable, and it was decided to return to the more modest arrangement of a prize distribution in the Society's Great Room. In that year two separate meetings were arranged, one for the prizes in Polite Arts, and the second a month later for the other awards. In the following year a single meeting only was held and all the prizes were presented on the same day. This arrangement, however, was not popular, and in 1831 Exeter Hall was engaged. The same plan was followed

* *Journal*, Vol. LIX., September 22nd, 1911, p. 1021.

* These Rooms were on the east side of Regent Street, at the corner of Little Argyll Street. They were built by Nash in 1818, and must not be confounded with the Argyll Rooms in Windmill Street, which, as Mr. Wheatley says in "London Past and Present," acquired an "unsavoury reputation" and had no history.

† The King's Theatre or Haymarket Opera House, later known as Her Majesty's Theatre.

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for the next four years. Then for three years (1836 to 1838) the Society went to the Hanover Square Rooms, and in 1839, again hampered by failing resources, it came back to the Adelphi and had its annual distribution in its own meeting room.

In June, 1840, the Duke of Sussex proposed Prince Albert for membership of the Society, and he was at once elected. The Duke of Northumberland and Lord Radnor were his other sponsors. His Royal Highness qualified as a life member. His marriage with Queen Victoria had taken place in the previous February, when an address was presented by the Society to Her Majesty.

Three years later, in April, 1843, the Duke died, and it was at once determined to invite Prince Albert to succeed him. A deputation of three of the most distinguished Vice-Presidents—the Duke of Buccleuch, the Duke of Sutherland, and the Marquis of Northampton—was appointed to invite H.R.H. to accept the presidency. The Prince at once acceded, and was elected president on May 26th of the same year. He entered on his duties by presiding at the annual distribution of awards in June.

The number of Vice-Presidents varied from time to time. There were twelve at the end of the eighteenth century, nearly all great noblemen, with a few distinguished men, who took a more active share in the Society's proceedings. The numbers were increased to about twenty later, most of the additions being of the latter class, more or less active workers, and in 1843 a distinction was actually drawn between the "Honorary" and the "Acting" Vice-Presidents. There were also eighteen Chairmen of Committees, two for each of the nine Committees, which remained unchanged for very many years. These were the six Premium Committees—Arts, Agriculture, Manufactures, Mechanics, Chemistry, Colonies and Trade, with three others—Accounts, Correspondence and Papers, and Miscellaneous Matters.

The paid officials were the Secretary, Assistant-Secretary, Registrar and Collector. These, with the President, Vice-Presidents, and Chairmen of Committees, were all elected at the annual meeting.

Dr. Templeman* was succeeded as secretary by Samuel More, who had indeed discharged most of the duties of the office during the long illness which preceded Templeman's death. He held the post for over thirty years, for he was elected in January, 1769 (Templeman died in the preceding October), and died in October, 1799, at the age of seventy-four. He was evidently a capable and efficient secretary, keenly interested in the Society's work. He had been an active member for some ten years before he became secretary, and seems to have been both respected and popular. Of his private life not very much is recorded. A short paragraph in the *Gentleman's Magazine* reports his death, and in the Preface to Vol. XVIII. of the *Transactions* there are some laudatory comments on his work. No biographical information is given, "because it is expected that a full account of him will be prefixed to the publication of some valuable papers which it is said he has bequeathed to the world." This intention, however, does not appear to have been carried out, as no trace of such a publication can be found.

The estimation in which he was held by the members is shown by the fact that he was presented with a gold medal in 1794 "For eminent services," and also by the inclusion of his portrait in Barry's picture, "The Society." His portrait was also painted for the Society by Benjamin West, P.R.A., in 1796. A fine engraving of the picture was made by W. Sharp.* He contributed two papers to the *Philosophical Transactions*,† and one, on standards for weights and measures, to the Society's *Transactions*,‡ besides his unsigned contributions.

It was during More's secretaryship that the *Transactions* were commenced. The need of some permanent record of the Society's proceedings was recognised at a very early date. It was obviously of little use to stimulate invention or to reward progress, unless full information of the results obtained could be made public. The Society soon became possessed of a good deal of valuable information contributed by the competitors for the awards, and this it was at first proposed to publish in a "Historical Register," arrangements for the preparation of which, it appears from the minutes, were on several occasions discussed. Instructions were given to Templeman to prepare such a Register, and two MS. volumes are in existence, apparently bound at a later date, and entitled "Dr. Templeman's Transactions." These, however, consist merely of extracts and compilations from the minutes, a copy of the

* *Journal*, Vol. LIX., June 9th, 1911, p. 774.

* William Sharp (1749–1824), "One of the most celebrated of English line engravers."—Bryan.

† "Some Scoriæ from Iron Works." *Philosophical Transactions Abr.* Vol. XV. p. 182 (1782); "Account of an Earthquake felt in the Northern Part of England." *Ibid.*, Vol. XVI. p. 176 (1787).

‡ *Transactions*, Vol. XII. p. 292.

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1759 premium list, the "Rules and Orders," a list of members elected from April, 1755, to April, 1758, and similar matter. There are only two documents of any importance. One is a manuscript copy of the pamphlet published in 1721, containing a proposal for the formation of a London "Chamber of Arts," referred to in the first article of this series.* As no copy of this pamphlet, so far as the present writer is aware, has been preserved, Dr. Templeman's MS. copy is of interest. The scheme suggested is so much like that of the Society, that it looks as if Shipley, or some of the founders, was familiar with the proposal. There is also a copy of a draft charter for an Academy of Arts without any date. This was no doubt the draft submitted to the Society in 1755 by Sir Henry Cheer, but not approved. It is very full and complete, but the scheme was one for an Academy of Arts, not for an industrial Society, such as was really in the minds of the founders of the Society of Arts.

On the whole, it is fairly evident from the contents of these volumes that if Dr. Templeman had been able to complete and publish his "Historical Register," it would not have added very much to the information available about the Society's early years.

According to a statement of Arthur Young's,† a good many of the communications made to the Society were published as pamphlets, in the book "De Re Rustica,"‡ in the *Gentleman's Magazine*, or in other periodicals. Descriptions of some of the machines rewarded by the Society are to be found in an illustrated work entitled "The Advancement of Art, Manufactures, and Commerce, or Descriptions of the Useful Machines and Models contained in the Repository of the Society," published in 1772, by William Bailey, who was then Registrar to the Society. It is a quarto volume with a collection of fine illustrations in folio. In 1782 another edition was issued by A. M. Bailey, who succeeded his father as Registrar in 1773. It is in two volumes, folio. The book is of some value, as it contains accounts of several pieces of apparatus not elsewhere described, and the illustrations are very good.

The first publication, however, which regularly published a selection from the proceedings of the Society was the *Museum Rusticum et Commerciale*, a monthly journal, of which six volumes were issued, each containing six of the monthly parts. This commenced in 1764 and came to an end in 1766. It had no official connection with the Society, but it provided a means of publication for some, at all events, of the more important and interesting matters which were brought before it, though it was by no means restricted to the Society's proceedings.*

This casual and unofficial method of publication proved unsatisfactory, and its failure suggested to Robert Dossie, an active member of the Society, the production of a similar work which should contain such memoirs as the Society desired to publish, together with other contributions, and also selections from the published proceedings of foreign societies devoted to the Arts and Sciences. An arrangement was entered into between Dossie and the Society, under which he undertook to publish, and they to provide, such communications as seemed suitable to both parties. With this understanding, Dossie started his "Memoirs of Agriculture and other Oeconomical Arts," the first volume of which was published in 1768, and contains a resolution, passed by the Society in June, 1767, to the effect that they "will occasionally publish in this Work such Pieces as they shall think proper to lay before the Public." It is entirely made up of the Society's proceedings, and begins with a list of all the awards, other than those in Polite Arts, up to end of 1767; next follows a brief statement of the Society's receipts and expenditure to the same date; and after this is a well-written and excellent account of the Society's proceedings, presumably prepared by Dossie himself. This occupies the greater part of the book, and it is in these pages that the whole early history of the Society is to be found. The last hundred pages contain seven articles, all but one devoted to agricultural subjects, the one exception being an account of the methods for dyeing Turkey leather, for disclosing which a reward had been granted to one Philippo. This first volume was followed by two others, Vol. II. in 1771, and Vol. III. in 1782. The later volumes contain a few articles besides those contributed by the Society, and are for the most part devoted to agricultural subjects. Vol. III. continues the list of awards down to the year 1776, and also gives a complete list of the premiums in "Polite

* *Journal*, Vol. LIX., June 9th, 1911, p. 768.

† "Farmer's Letters (Second Edition, 1771), Vol. I. p. 256.

‡ "De Re Rustica, or the Repository for Select Papers in Agriculture, Arts and Manufactures." London: Two Vols., 8vo., 1771.

* Two of the chief contributors to the *Museum* were Arthur Young and Robert Dossie. Young states in his Autobiography (edition of 1898 by M. Betham-Edwards, p. 33) that the "Farmer's Letters" consisted of his scattered papers in the *Museum Rusticum*, which, at the suggestion of the Rev. Walter Harte, he republished, with additions, in a volume. Dossie contributed several articles signed "Agricola," and possibly other papers.

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Arts" down to the same year, with some useful biographical notes about the prize-winners. Dossie's intention of continuing the general history of the Society was, unfortunately, never fulfilled, and, indeed, it is probable that it was interrupted by his death, which happened certainly not later than 1783. The catalogue of the Advocates' Library gives 1777 as the date, but this can hardly be correct. In Vol. II. of the Society's *Transactions* (published in 1784), he is referred to as the "late Mr. Dossie," and the preface to Vol. III. of the "Memoirs of Agriculture" (1782) is signed by him.

Not very much is known of Robert Dossie, who was certainly a skilful chemist, and an accomplished writer. He was a friend of Dr. Johnson's, and almost the only reference to him which appears in contemporary literature is to be found in Boswell:—

"Johnson was well acquainted with Mr. Dossie, author of a treatise on agriculture, and said of him, 'Sir, of the objects which the Society of Arts have chiefly in view, the chymical effects of bodies operating upon other bodies, he knows more than almost any man.' Johnson, in order to give Mr. Dossie his vote to be a member of the Society, paid up an arrear which had run on for two years."*

There is a short and inaccurate notice of him in Donaldson's "Agricultural Biographies," and beyond this there seems nothing beyond scattered references in the Society's records, and his own books. He was the author of several works on chemistry, and he was connected, as a contributor, if in no other way, with the *Museum Rusticum.* He received a gold medal from the Society in 1766 for "aiding to establish the manufacture of potash in North America," and before this, in 1761, he had received a grant of £100 for his method of purifying oil. As he was a member at the time this would appear to have been irregular, as members were not eligible for money prizes, but the grant was made in consideration of the expense to which he had been put in experimenting, and no doubt this was considered sufficient justification. He was a candidate for the office of secretary in 1760, when Dr. Templeman was elected, and it was after his failure to secure this office that he became a member. He was an active and useful member of the Society, and a frequent attendant at its committees.

* "Boswell's Life of Johnson," Birkbeck Hill's Edition, 1887, Vol. IV. p. 11. Dr. Johnson paid two years' subscriptions on March 25th, 1760. Dossie was elected on April 2nd of the same year.

It may have been Dossie's death, and the consequent discontinuance of the "Memoirs of Agriculture," that brought to a head the proposals for a regular series of *Transactions.* Valentine Green claimed the credit for carrying the proposal through, and from the minutes it appears that the final decision to publish transactions was due to his efforts, but Arthur Young, apparently with justice, claims to have originated the idea. In his autobiography he says,* under the date 1772:—"This year I attended very much the meetings of the Society for the encouragement of Arts, Manufactures and Commerce, as well as the Committee of Agriculture, of which I was chairman. In a letter from Mr. Butterworth Bayley, he lamented the want of a respectable publication by the Society of Arts, and called on me to think of some means of remedying the misery. When I became chairman of the Committee of Agriculture, I was the first to propose that annual publication which afterwards took place. This proposition was at once acceded to, and Valentine Green, the engraver, had the impudence to assert that it originated with him."

In this Young probably refers to his remarks above referred to in the "Farmer's Letters" of 1771, in which he dwells very earnestly and with much force on the necessity of the Society publishing *Transactions,* and points out that the value of the premiums, though in some cases they are "truly munificent," is greatly lessened by the absence of any published record.

The first volume of the *Transactions* was published in 1783. It compares rather unfavourably with Dossie's skilful compilation. The original papers are neither numerous nor important, and the bulk of the volume is made up of mere official records, necessary but insufficient by themselves. Subsequent volumes show a marked improvement, and the records of the Society's proceedings bear a more reasonable proportion to the purely official matter. The series was continued to 1844, when it ceased with Vol. LV.† Up to 1830 an annual volume was published, but from that date to 1843 (Vols. XLVIII. to LIV.) each volume consisted of two annual parts. Vol. LV. contains only the proceedings of a single session, that of 1843–4. In 1848, a few years later, an attempt was made to start a new series, and a volume was published purporting to

* "Autobiography of Arthur Young" (edited by M. Betham-Edwards), 1898, p. 59.

† A general index to the contents of previous volumes of the *Transactions* is given in Vols. XXVI. (1808), XL. (1823), and L. (1836).

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contain the proceedings for the sessions 1846–7 and 1847–8. It is a handsome quarto volume, containing some good illustrations, a selection of papers read before the Society, and the Charter. This was eventually treated as Vol. LVI., though on the titlepage (which bears the date 1852) it is called a "Supplemental Volume." In December, 1851, a volume, called Vol. LVII., was published, containing the proceedings for the session 1850–1. It corresponds in form with the original series, and is in no sense a continuation of Vol. LVI. After this no further *Transactions* were published.

In 1845 there was commenced an issue of a publication called the "Abstract of Proceedings." This was published weekly during the session while meetings were being held. At first it consisted only of a few octavo pages of notices and general information about the Society, but from 1848 onwards it contained abstracts of the papers read. A little later it was entitled "Weekly Proceedings," and in this form it continued till the end of the session for 1851–2, the last number being dated July 17th, 1852. The number for June 12th contains a note stating that the Council were considering the publication of "a stamped weekly Journal," and with the new session the *Journal of the Society of Arts* was started. The first number of the Journal was published on November 26th, 1852.

After the death of More in October, 1799, the usual steps were taken for the election of a new secretary. Amongst the candidates who applied, besides Charles Taylor, who was successful, were included the Rev. Edmund Cartwright, the inventor of the power-loom, and Valentine Green.* Valentine Green had for very many years taken a leading part in the Society's affairs, but he had been involved in a very serious loss by the failure of his scheme for publishing the collection of prints from the pictures in the Dusseldorf Gallery. It was no doubt this which made him apply for the secretaryship, as it afterwards led him, on the foundation of the British Institution in 1805, to accept the office of Keeper. The committee, which subjected all the candidates to a severe catechising, rejected Green, but recommended as qualified Taylor, Cartwright and another.

* Valentine Green (1739–1813), the well-known mezzotint engraver, was a member of the Society from 1772 till his death. He was one of the most regular attendants and took an active share in its proceedings. He was Chairman of the Committee of Polite Arts from 1780 to 1786, and Chairman of the Committee of Correspondence and Papers from 1787 to 1797. In 1773 he received a gold medal "For repeated services."

Cartwright submitted a special memorial of his qualifications, which was afterwards published* in a volume together with some further information relating to his improvements in the steam engine, and his mechanical inventions. Much of the matter it contains was incorporated in the memoir of his life afterwards published by his daughter, Mary Strickland. His qualifications were considerable, for his experience not only of textile machinery, but also of agriculture, was very great. He received three medals from the Society, a silver medal in 1803 for a plough, a gold medal in 1816 for a horse gear, and a gold medal in 1817 for experiments on manures. Shortly before the date of the election, Cartwright withdrew, and this left the field practically open for Taylor, who was elected by a large majority.

Taylor was an accomplished chemist, and, according to his statement to the committee, he was known to almost all the chemists in Europe. He informed the committee that he was the inventor of a method of calico printing "by wooden cylinders and sliding metallic cylinders." He also claimed to have furnished the Government with valuable information on indigo, which had led in the eight years from 1789 to 1797 to an increase in the value of the export of indigo from the East Indies from £110,000 to £558,000. Taylor was for some time engaged in the cotton manufacture in Manchester, but, as the short notice which appeared in the *Transactions* after his death states, "the opulence which flowed so exuberantly to many of his fellow-townsmen did not find its way to him."† He was also among the first to utilise Berthollet's discovery of the applicability of chlorine for bleaching, and was said to be "the first to produce for sale in the Manchester market an entire piece of calico bleached by oxy-muriatic acid." His death took place in 1816, after sixteen years' service. He appears to have devoted himself energetically to his duties, and to have made an efficient secretary, without being a man of scientific eminence.

Arthur Aikin, who succeeded Taylor in the secretaryship, had, even when he was elected in 1817, though he was then only about thirty-four years of age, acquired a much greater scientific reputation than his predecessor. He had already been one of the founders of the Geological Society, which was established in 1807, and had published,

* "A Memorial read to the Society of Arts . . . With an Appendix." 1800.

† *Transactions*, Vol. XXXV. (1818) p. 8.

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in connection with his brother Charles, a dictionary of chemistry and mineralogy and some other works. From 1811 he had been honorary secretary of the Geological Society. He was an accomplished chemist, and was familiar with several branches of industrial chemistry. He told the committee, on his examination for the post of secretary, that he was then occupied in drawing up patents, and in advising on scientific matters. He had also a very considerable knowledge of metallurgy, and was a good botanist. He was the eldest son of John Aikin, M.D., a brother of Lucy Aikin, and a nephew of Mrs. Barbauld. His father was a friend of Priestley, and it was his association with that distinguished philosopher that led Arthur Aikin to the study of science. He was first intended for the Unitarian ministry, but he abandoned this idea in early life, and devoted himself entirely to science. He held the office of secretary for twenty-three years, and on his resignation in 1840, he became chairman of the Committee on Chemistry. He also became the first treasurer of the Chemical Society, which was founded in 1841 at a meeting held in the Society's room, and afterwards (1843–45) its President. He was never married, and died in 1854.*

To Aikin was certainly due the initiative of a change in the Society's methods, which ultimately had the result of turning the Society from a purely premium-giving body into one whose main object became the dissemination of information about the industrial arts and sciences, and the publication of new discoveries and inventions of an industrial character. The change was not effected during Aikin's secretaryship, but it was certainly completed before his death, though that completion was effected by other hands than his. The foundation was laid by his proposal that courses of lectures on manufactures should be organised, and arrangements made for the reading and discussion of papers at the evening meetings.

So far as the lectures were concerned Aikin not only suggested that they should be given, but gave them himself. From 1829, when the scheme was first started, to 1842, after he had resigned the secretaryship, he continued to deliver, year after year, excellent and well-illustrated courses on various branches of manufacture. The subjects were very varied. They include glass, pottery, paper-making, furs, tanning, silk, sugar, artificial lighting, timber, horn and tortoiseshell, and other equally divergent topics. At first practically the whole of the work was carried out, and very efficiently carried out, by the secretary, though after two or three years Aikin only gave one or two of the "illustrations," and the bulk of the work was taken over by others. The lectures were much appreciated, and did something to keep up the waning popularity and reputation of the Society. Aikin received no payment for the work, and a proposal in 1831 to present him with a gold medal was not carried, though the award was fully merited, and might well have been given. There is nothing in the minutes to show why the proposal was not adopted, but it appears that Aikin himself declined it, on the ground that he was an officer of the Society. At all events, a vote of thanks was substituted, couched in very warm and complimentary terms. Before he resigned his office, however, a testimonial was presented to him, in the form of a valuable microscope, with an inscription testifying to the esteem in which he was held, and to the value at which his services to the Society were rated. The instrument is now in the possession of his grand-nephew. However, he got his gold medal eventually, for when he retired in 1839 it was voted to him unanimously, and he was also made a life member. Few compliments could have been better deserved, for during his twenty-two years' service he devoted himself earnestly to the Society, and it was certainly no fault of his that his single-minded efforts were not entirely successful. In after years his labours bore fruit, and he lived long enough to see their results.

Even more important as regards its permanent effects was the substitution of papers and discussions at the ordinary meetings for the mere consideration of inventions competing for prizes. There is no definite evidence in the records to prove that this was Aikin's doing, but there is not much doubt that it was due to his initiative. Among the suggestions made in 1828 for rendering the meetings more attractive was one that, instead of confining the discussions to inventions submitted for awards, a notice should be issued that the Society would welcome communications of interest on suitable subjects for reading and consideration only. Such papers had indeed always been received, and, if considered worthy, printed in the *Transactions.* As far back as 1784, Daines Barrington made two interesting communications to the Society, one on silk

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* The first regular meeting of the Chemical Society was held on March 30th, 1841. After this, for some time, its meetings were held fortnightly at the Society of Arts' House. See *Gentleman's Magazine* (N.S.), Vol. XV. pt. 1, p. 527.

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and one on tobacco, and both were published in the second volume of the *Transactions*. But such papers were rare, and it was considered to be contrary to the spirit of the Society to invite them, because it looked like holding out an offer of a prize and so prejudging the decision of the members. It was, however, realised that publication was often more important than the grant of a medal, and that many inventors and students would welcome the chance of publishing their ideas who would not care to enter in competition for a prize, or might, for various reasons, not be eligible, if they did. Accordingly a notice was issued in the *Transactions* for 1829, that papers would be received for reading and publication only. The proposal proved popular, and before long such papers were found to be among the most important contributions to the annual volume. The system gradually developed, until in another ten years we find that the reading of such papers came to be the most important business of the meetings, as eventually it became the most important business of the Society. And when, as we shall see later, the whole proceedings of the Society were reformed, a special committee was appointed to secure suitable papers. At first they were only printed in abstract, but even in this form they are interesting, and among them are many communications of importance.

It was in May, 1839, that Aikin sent in his resignation, but he did not actually retire till the beginning of the new session in the autumn. In December, W. A. Graham was elected as his successor, but he only held office for three years, for he resigned in December, 1842.

During the period covered by the secretaryships of Templeman, More, Taylor, and Aikin, there were many changes in the staff of the Society. As stated in a previous article, Box became assistant secretary on the appointment of Templeman as secretary. He held the office till 1779, when he retired from failing health, having served the Society in various capacities for twenty-three years. Till 1771 he also acted as collector, when he gave up this part of his duties, no doubt in consequence of his health, which, it appears, was but feeble for some years before he actually resigned. He was succeeded as collector by Abraham Brockelbank, the man who was first appointed (Thomas Dawson) being discharged after a few months, because he was unable to find the necessary security. As assistant secretary he was followed by Richard Samuel, who was elected in May, 1779. He died in the summer of 1787, and was followed by John Samuel, presumably a relation, who was first appointed temporarily to do the work, and was formally elected in November, 1787. He served for a little over ten years, and died just before the annual election of officers in March, 1798, when the post of assistant secretary was left vacant. Bowman, the collector, was engaged to fill the vacancy, pending the regular appointment of a new assistant secretary, and in April, 1798, Thomas Taylor was elected.

Taylor, known as the "Platonist," was distinctly an eccentric character. He was an ardent student of the Greek philosophers and of mathematical philosophy, though he was absolutely unqualified either by aptitude or education to appreciate either branch of knowledge. He was the son of a London stay-maker, and was born in 1758. Though he was at St. Paul's School for three years, he does not seem to have profited much by the teaching he got there. After serving as an usher in a Paddington school he obtained a clerkship in Lubbock's Bank, and appears to have eked out his moderate financial resources by literary hackwork. Being lucky enough to have an annuity of £100 left to him, he gave up his clerkship, and applied for the assistant secretaryship. He held the post for seven years, till November, 1805, when he resigned on the ground of ill-health. He wrote in a very desponding tone about his health, but recovered, and lived for another thirty years, devoting himself assiduously to the work of translating and expounding the writings of the ancient philosophers. "His equipment for this enterprise left much to be desired. Critical faculty he had none. No doubt of the historic personality of Orpheus or the authenticity of the hymns ascribed to him ever crossed his mind; the mystical neo-Pythagorean mathematics he esteemed the true science, which the Arabians and their European successors had corrupted. . . . But with an ardour which neither neglect nor contempt could damp, he plodded laboriously on until he had achieved a work never so much as contemplated in its entirety by any of his predecessors."* This is rather a hard saying, but it appears to be justified. Still, Taylor seems to have been a kindly and amiable character. Although he was, and probably always will be, regarded as a half-crazy enthusiast, he had many friends, and appears to have been much liked. The list of his translations and dissertations occupies nearly three columns of the "Dictionary of National Biography,"

* Life of Taylor, by J. M. Rigg, in the "Dictionary of National Biography."

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so he was a most laborious and industrious author. The best, perhaps, that can be said of his writings is that they were voluminous. They were certainly but little appreciated when they were written, and the lapse of time has added neither interest nor value. He died in 1835.

When Taylor resigned, his post was temporarily filled by John Taylor, who was apparently a relation, perhaps his son, as he is spoken of as "Mr. Taylor, jun.," and in February, 1806, Charles Combe was appointed. He only held the post for less than a year, for he resigned in January, 1807, and in the following March Thomas Woodfall was appointed. He was a son of William Woodfall, a brother of Henry Sampson Woodfall, the publisher of "Junius's Letters," and the conductor of the *Public Advertiser*. William was a journalist and reporter, endowed with an extraordinary memory, on which he relied for his reports. Thomas Woodfall had a printing business, which he was allowed to retain after he became assistant secretary, and he seems to have done some of the Society's printing. He continued in the Society's service till 1842.

When, in October, 1760, Shipley resigned the office of Registrar (the title is always spelt "register"), he was succeeded by E. G. Tuckwell, who continued in office till 1766. On his resignation William Bailey was appointed. His excellent account of the machines and models in the Society's collection has already been referred to in these articles. He died in January, 1773, and the post was given to his son, Alexander Mabyn Bailey. He held it for six years, but resigned in March, 1779, to avoid discharge. He seems not to have given satisfaction, and the Society, for some reason, disapproved of his action in bringing out a second edition of his father's book, or, at all events, in soliciting subscriptions for it. This second edition was, however, duly brought out, and, so far as the work itself goes, it is a credit to the Society.

He was succeeded by a man whose name was associated with the Society for nearly eighty years. George Cockings was appointed porter in November, 1765, in place of a man discharged for accepting a gratuity of £5 from a candidate for a premium. In 1777, when Brockelbank died he succeeded him as collector, and when A. M. Bailey resigned, he was appointed registrar. He had wished to offer himself for the post in 1766, but this had not been permitted. His election as registrar took place in May, 1779, at the meeting when Richard Samuel was elected assistant secretary.

Before he entered the Society's service, Cockings had held some small Government appointment in Boston, North America. He is noticed in various biographical dictionaries (including the "Dictionary of National Biography"), on the ground of his having produced certain inferior poems and dramas. Of most of these the present writer is not in a position to offer any opinion, as he has not felt it his duty to study them, but one particular epic, "Arts, Manufactures and Commerce," written in 1766, no doubt in the first flush of satisfaction at being appointed porter, he has sampled, and he can only express a regretful belief that the very contemptuous opinions of the critics of his other works are probably fully justified.* But Cockings was a better official than he was a poet. He worked himself up from a very humble post to a responsible position. In one capacity or another he served the Society well for thirty-seven years, and he evidently gained the esteem and approval of his employers long before his death in February, 1802.

For some years before his death, he had been assisted in his work by his daughter, Ann Birch Cockings, and she was appointed his successor, with the title of housekeeper, but practically with the same duties as her father. This office she held for forty-two years, till her death in February, 1844. She was evidently a very remarkable woman, endowed with great force of character, and it is quite clear that, during the later years of her life, she practically ruled the Society. Tradition records that she had a

* It may be but reasonable to give readers an opportunity of judging for themselves. The following extracts are fair specimens, and are selected because of the courage they show in compelling the muse to treat subjects generally held to be beyond her competence:—

"On Principles of Skill, (well understood,)
With plain intelligible Aptitude,
To polish Glass, a new Machine comes forth,
(Whose future Trials may proclaim its Worth ;)
'Tis work'd by windy Pow'r, or watry Force,
Or by a circumambulating Horse :
Two diff'rent Ways the Crank, the Runner guides,
As o'er a subject Plate it gently glides ;
By other Cranks, some Polishers are made
At first t'advance, and then turn retrograde ;
And as they o'er the Spheres, and Basons pass,
Polish the convex, and the concave Glass."

And again :—

"Efford contrives a Rod, by Rules of Art,
For Mensuration of th' internal Part
Of any Cask, which gives th' exact Contents,
Better than any other Instruments :
Inserted thro' the Bung, compactly shut,
And thro' the Liquid perpendic'lar put,
By an expanding Pow'r, 'tis open thrown,
Both Bung, and Length, at once are truly shown."

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bitter tongue as well as a strong will, and the story already told of her* may serve to show the view she took of her own duties, and of her relation to the other officials of the Society. She became eventually, in name as well as in fact, registrar and librarian, as well as housekeeper, and if she never assumed the title of secretary, she probably did her share even of the secretary's work. Apparently a truculent and masterful old lady, she was an earnest and devoted servant, who was appreciated and esteemed by the masters whom she ruled. When she died, they subscribed for a monument in Kensal Green "in grateful remembrance of the perfect integrity and the constant and zealous diligence with which she performed the duties of her office."†

Aikin was certainly the most accomplished secretary the Society had had since the death of Templeman, but this did not prevent the Society's decline during the term of his office. This is not to say that he was in any way to blame for the result, and indeed it appears from what has been said above that he realised that the time had come for a change in the Society's methods, and he did his best to initiate such a change. There is good authority for saying that he in later life stated to his brother and his nephew that he could never get his ideas properly supported by the influential members of the Society, and the history of the years immediately following his resignation renders the accuracy of such a statement not only probable but obvious. It is very likely that he was not specially endowed with those qualities which go to make a good man of business, but he was a man of refined and cultivated intelligence, who had also the gift of making himself liked by those with whom he had to work. Still the fact remains that at the end of his secretaryship the influence and reputation of the Society had reached a very low point. Its resources had fallen off and the number of its supporters had seriously diminished. As a matter of fact, the Society's revenues had been for some years decreasing. Its period of greatest prosperity was in the first ten years of its existence. The largest amount subscribed in any one year was in 1763, when a sum of £4,614 was collected. In succeeding years we find a gradual falling off, till at the end of the century the average income was about £2,000. In 1804 a careful examination was made into the Society's financial condition, and an analysis of receipts and expenditure for the seven years ending with 1803 is given in one of the volumes of committee minutes. From this it appears that the annual receipts just balanced the annual expenditure, there being a trifling surplus, about £150, on the results of the seven years' work. At this date about £50,000 had been expended in premiums since the Society's foundation. For the next quarter of a century the income fluctuated about this same figure, with a tendency to decline, and then it began to drop, till we find that the balance-sheet for the year ending June, 1837, shows a total revenue of only £1,235, and a debt of nearly £300. After this things went from bad to worse, until, as we shall see later on, the Society was reorganised, and its affairs again put on a prosperous and satisfactory footing.

The causes for this unfortunate condition of an institution which had for long been so prosperous and so popular were no doubt various. The political and economic state of the country may have contributed. For long after the end of the Napoleonic wars there was serious industrial depression, and this must have reacted on a Society whose main objects were industrial. Also it had to contend with the competition of many similar institutions. By the end of the first half of the nineteenth century there had been founded the Royal Academy, the Linnean, Geological, Chemical, Agricultural and Geographical Societies, the Royal Institution and the London Institution, the Institutions of Civil Engineers and of British Architects —all occupying ground once left to the Royal Society and the Society of Arts. But it is certain that the main factor was the obsolete character alike of the Society's objects and of the manner in which they were carried into effect. Its constitution badly needed reform, and until that reform was effected, as it was a few years later, the Society remained incapable of useful work, and consequently not likely to receive public support.

The idea of encouraging industrial progress by the award of prizes, useful at a time when practical applications of science were unknown, and invention required all the artificial stimulus it could get, was out of date. As the provision of such prizes was obviously ineffective, people were less ready to provide money for them, and so the whole scheme came near collapse. Besides, had the scheme been sound, the manner of its administration was ineffective. The whole business of the Society was carried on in open meetings, which all members had a right to attend, and at which consequently the

* *Journal*, September 22nd, 1911, p. 1022.
† *Transactions*, Vol. LV. (1845) p. 17.

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attendance was always different. The natural result was that the less work there was to do, the more time there was spent in doing it, and the more talk in getting it done.

The consequence was that as there was not much to do, the time was expended in discussing the proper way of doing it, and in making elaborate regulations to that end. The story goes that Lord Brougham, on one occasion attending a meeting of the Society, went off with an outspoken declaration as to what he hoped might be his final fate if he ever wasted his time with a Society that spent all its time in discussing "rules and orders." Thus was lost to the Society the energy afterwards expended in promoting the Society for the Diffusion of Useful Knowledge and the Social Science Association, two institutions which owed much to Lord Brougham's exertions.

To such a serious condition had the Society's affairs come, that at the first meeting of the session 1841–2, the Committee of Accounts reported that it had practically used up all its available resources, that its revenue was insufficient to meet its expenditure, and that of its accumulated funds only some £400 was available to meet future deficiencies. A special committee was at once appointed to consider the position of the Society and to suggest "means by which the Society can be rendered more efficient, both as regards its objects, management, and constitution." The chairman of the committee was Thomas Webster,* and its appointment was the beginning of the much-needed reforms which he, and a small party of which he was the leader, eventually succeeded in bringing about. This committee, which was only appointed on November 17th, produced at the meeting of December 15th an excellent and exhaustive report, one characteristic of which was its extreme candour, and another the clear insight it showed into the causes of the Society's decay. Two passages are worth quotation:—

"Among the causes which have contributed to the present state of the Society, the most prominent appears to be the want of an efficient governing body to direct the general proceedings and the internal regulations, upon the proper control of which the success of every society so much depends.

"From the period when the Society was established to the present time, the system pursued has differed from that of all other societies instituted for the promotion of science and art, in which a council or committee of general management has always been considered essential.

"The want of a superintending council was not for many years perceived or felt. But with the rapidly-spreading taste for useful knowledge and scientific pursuits, other societies arose of a popular character, and the consequences soon became apparent in the diminished funds of this Society, whose great object is the promotion of the useful arts rather than the personal gratification of its members."

* * * *

"Another prominent cause has been the withdrawal of active members from the committees, the consequence of which has been a want of confidence in the decisions and a falling off in the number and value of the reports of the committees. These, and other causes combined, have led to a decline in the interest of the weekly meetings, the proceedings of which are now principally confined to discussions of rule and order, accounts and other matters, not tending to promote the interest of the Society."

After some very judicious remarks on the wide field open to the Society, notwithstanding the competition of newly-instituted societies with more specialised objects, in the application of science to the arts and manufactures, it goes on to suggest the formation of a governing body or council, to consist of the chairmen of the six principal committees, the president, two vice-presidents, and two treasurers. The three other committees would be abolished, their duties being transferred to the council.

Among the various other suggestions made in the report, certainly the most important are that the principal object of the Wednesday evening meetings should be the reading and discussion of communications on the arts and manufactures of the country, and that the exclusion of patented inventions from awards had been "extremely detrimental to the interests of the Society."

However, when this very judicious report was submitted to a general meeting of the Society in the following January (1842) it met with distinct opposition. Eventually most of its proposals were disapproved, and after a good deal of argument, another committee was appointed, which in its turn reported advising a number of economies, the result of which

* Thomas Webster (1810–1875), afterwards Q.C., and an eminent patent lawyer. At this time he had only lately been called to the Bar, after acting for two years (1837–39) as Secretary of the Institution of Civil Engineers. Associated with him in the reform of the Society were Edward Speer, George Bailey, J. Scott Russell (the eminent engineer, afterwards Secretary), John Bethell, Joseph Woods (architect, geologist, and botanist), and William Tooke (solicitor). Thomas Webster's second son, Richard, afterwards became Lord Alverstone, L.C.J., and he has followed his father's example by his devotion to the interests of the Society.

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must certainly have been the winding-up of the Society for good and all. One of these suggestions was that there should no longer be a salaried secretary, but that the office should be placed in commission, its duties being discharged by a committee of five members. Graham, the secretary, promptly resigned his office, and things appear to have got into a general muddle. Webster's committee was reappointed, and they prepared a report practically on the same lines as their previous one. This time they took the precaution of submitting it to the President, the Duke of Sussex, who cordially approved it, adopted it as his own, and sent it as such to the general body. It was, of course, accepted without much further demur, and in April, 1843, it was adopted. In the following month a resolution of thanks to Webster was passed, which shows that, in spite of what seems to have been merely factious opposition, the Society appreciated his labours on their behalf. This was the last service rendered by the Duke to the Society, for he died in the following April. It was, however, no trifling one, for it enabled the necessary reforms to be effected, and thus helped to start the Society on a new and prosperous career.

Part of the committee's work was to provide for the immediate carrying on of the regular work of the office. They therefore recommended that a temporary arrangement for filling the office of secretary should be made, and at their request Webster undertook to find a suitable person. He had but lately resigned the office of Secretary of the Institution of Civil Engineers, and was therefore thoroughly familiar with the ordinary routine of a society's work. At a meeting of the Miscellaneous Matters Committee in January, 1843, he produced a letter from Francis Whishaw, an engineer, who was then known principally as the author of a volume published in 1840 on "The Railways of Great Britain and Ireland," in which Whishaw offered to act temporarily as secretary on the terms proposed — two guineas a week, together with the use of certain of the rooms in the secretary's house. This offer was accepted, and Whishaw was appointed. At the annual election in April, 1843, Whishaw's name was placed on the balloting list, and he was duly elected at a salary of £150 a year and a house.

Among other recommendations of the committee was included one to the effect that it was not desirable to continue the office of assistant secretary, and notice was given to Woodfall in March, 1843, that his services would be dispensed with, but that his salary would be paid until the end of the session, and that he would have an additional grant of £100. A very complimentary vote of thanks was also passed to him at the annual meeting, and he was presented with a set of Barry's etchings, a gift which at the time was made by the Society to various people to whom it was desired to pay a compliment. Woodfall at first protested, but eventually expressed himself as entirely satisfied, although he said that it was with very great regret that he gave up a service which he had held for thirty-seven years. He appears to have discharged all his duties efficiently. On several occasions additional grants were made in augmentation of his salary, which was always on a moderate scale.

For some months Whishaw carried on the work without assistance, but in October, 1844, he was authorised to engage somebody to help him, and he engaged S. T. Davenport, then a young man of twenty-one. Davenport developed into a very valuable and trusted official, for he served the Society in various capacities for over thirty years till his death in 1875.

Whishaw held the secretaryship for nearly two years, until November, 1845, when he wrote that he wished to resign, as he had accepted some other work which would prevent his giving proper attention to that of the Society. This work appears to have been an appointment in connection with Prosser's wooden railway.* At the same time he stated that Mr. Scott Russell was willing to undertake the work of secretary, and proposed that he should be nominated jointly with himself. This offer was accepted, and Scott Russell was appointed. At the annual election in the following year, in April, 1846, Scott Russell was elected secretary, Whishaw being elected corresponding secretary. In 1848 he was made auditor, and after this his official connection with the Society terminated; but he had been elected a life member on his resignation of the secretaryship, and he continued

* This was a scheme for the use of wooden rails, which it was thought would be cheaper than rails of iron. The inventor was William Prosser, the Secretary of the Metropolitan Railway Company, who took patents out for his invention in 1843 and 1844. An experimental line was laid down on Wimbledon Common. Although favourably reported on by Major-General Pasley, Inspector-General of Railways, the scheme never came into practical use. Prosser himself did well out of it, for his rights were purchased by the London and South-Western for £20,000. He also received £32,000 from an Irish line. A full account of the system will be found in the *Engineer*, January 5th, 1900, p. 9.

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to take an interest in the Society's work. The chief thing for which he is to be remembered is that he originated the idea of holding exhibitions, first on a small scale in the Society's rooms, and afterwards in the form of a national exhibition of industries. A full account of this work was given in an article in the *Journal* of November 6th, 1896, dealing with the early history of the 1851 Exhibition, and need not, therefore, be repeated here.

Although both before and after his connection with the Society, Whishaw appears to have been fully occupied in work associated with the construction of railways and of electric telegraphs, his career was, on the whole, not a fortunate one. In later life he seems to have suffered a good deal from illness, and eventually he died in October, 1856, in Marylebone Workhouse.*

The most important reform, however, suggested by Webster's committee was that a council or managing committee should be appointed, which should have full control of the Society's business, thus taking it out of the hands of the general body, and this was really the crux of the whole business. Though the change was greatly disliked by the excellent persons who had found amusement and occupation in the control of the Society's affairs, the reform had been passed, and, in order to carry it into effect, a complete revision of the old rules and orders of the Society was necessary. Such a revision was made, and in December, 1845, new rules and regulations were passed, establishing a managing committee or council, and giving that body the necessary powers. It was to consist of the chairmen of committees, together with a certain number of elected members. The first meeting of the council was held on December 6th, 1845, with Edward Speer in the chair. For the first few months of its existence, the council seems to have had no regular chairman, but after its election at the annual meeting in March, 1846, Edward Speer and George Bailey† were elected chairmen, and this arrangement was repeated in 1847 and 1848.

The council very soon got into active work, and the wisdom of the change became evident. Its proceedings, however, and the many useful alterations it introduced into the work and the character of the Society, will be more fitly considered when we come to deal with the history of the Society after the grant of a Royal Charter, the attainment of which was one of the first matters with which the new council dealt.

It is rather remarkable that no steps had ever before been taken towards making the Society a chartered body, although, as will be remembered, the suggestion that a charter should be applied for was one of the very earliest matters considered. Whether the original proposal contemplated a charter for the Society in its original form, or a charter for an academy of painting and sculpture, is not quite clear, but at all events it was in the latter form that the proposal was submitted to the Society in 1755, and, as previously mentioned, a complete draft of a charter for a Royal Academy of Arts is preserved among Dr. Templeman's papers. It may have been intended that the Society should be merged in such an academy. Probably this idea was not consonant with the notions of the original promoters of the Society, and it was for this reason that it was opposed and dropped, to be resuscitated later on by the committee of artists and successfully carried out in the foundation of the Royal Academy.

The question does not appear to have been brought up again till 1843. In December of that year the secretary (Whishaw) reported to the Committee on Miscellaneous Matters, that "the subject of the Society obtaining a Royal Charter had lately been a matter of conversation by two or three members, who were willing to subscribe £5 5s. each towards this desirable object." But nothing was done. In February, 1845, the question of applying for a Royal Charter was raised at one of the meetings, and was referred to the Committee on Miscellaneous Matters, but no result followed. At last, in February of the following year (1846), the newly-formed council took the matter up seriously, and recommended that steps should be taken to make application for a Royal Charter. In December of the same year we find that a draft of the Charter was submitted by William Tooke, who was then acting as the

* A full biography of Whishaw is given in the *Proceedings of the Institution of Civil Engineers*, Vol. XVI. p. 143. The account of his connection with the Society requires a little modification, for it attributes to Whishaw's efforts rather more importance than is actually their due. It does not mention his unhappy end, about which, however, there is no doubt. It is recorded in Boase's "Modern English Biography" (1901), Vol. III. p. 1306, and in the *Gentleman's Magazine* (November, 1856, p. 642). The facts have also been verified by the Clerk of the Marylebone Board of Guardians, who, at the request of the writer, very kindly made a search in the records of the Marylebone Workhouse.

† George Bailey (1792–1860) was the first Curator of the Soane Museum, having been designated for the post by the founder. He was articled to Sir John Soane, and remained in his service first as architectural assistant, and afterwards as confidential clerk. He became a member of the Society of Arts in 1821, and continued until his death in 1860. After serving, as above mentioned, as one of the two chairmen of Council for three years, he resigned membership of the Council in January, 1849.

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Society's honorary solicitor. This being approved, in the following March (1847) Tooke brought up a draft of the Charter, together with a petition, which, after they had received the approval of H.R.H. the Prince Consort, as President of the Society, were lodged in the Privy Council Office. In June, Tooke reported that the Charter had been passed, and that fees amounting to £400 in all were required—of these the official charges amounted to £308 9*s.* 2*d.*, and there was about £75 for office expenses.

With the grant of a Royal Charter, the Society entered on a new chapter of its existence, and at this point the record of its older history may fitly be closed.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Coal Strike.—Difficulty in obtaining good steam coal was experienced at many textile works some while before the coal strike was declared, and similar difficulty is to be apprehended for some time after peace has been arranged. After the first fortnight of the strike certain Lancashire and Yorkshire mills closed because of the exhaustion of fuel and of inability to pay the high prices demanded by coal holders. Others, by closing on one or two days in the week and paying prices three or four times higher than usual for coal of uncommonly low calorific value, have contrived to hobble along with varying degrees of inconvenience and expense. The specialisation of the industries has the effect of causing some to feel the burden of dear fuel more than others. Spinning mills require relatively more power than weaving mills, and also require the maintenance of a greater atmospheric heat, and again their cost of power is a larger factor in the price received for the goods. Where boiling is done, as in bleaching, dyeing and finishing, large volumes of steam are wanted for the heating of vats, and in a trade like woolcombing there is need both for high power and high heat. Until the introduction of improved stoking and steam economising appliances, steam used often to cost dyers and finishers of wool goods 12 per cent. of the cost of production, and although this has been cut down more than one-third in most quarters, the effect of multiplying this cost by four or five times can readily be appreciated.

Charges of 38*s.* and so a ton for worse fuel than that which normally costs 8*s.* have sharpened the desire for economy. The railway strike of last summer directed the attention of manufacturers to motor transit by road, and the coal strike has impressed men with a sense of the desirability of making changes that have long been recognised as advantageous, but have not been adopted for want of an immediate stimulus. Probably there are in all industries arrangements which would be revised were one starting afresh, and certainly in textile works there are several. In the way of new experiments, devised to meet the emergency, an attempt to use oil fuel may be mentioned. Spraying oil direct upon burning coals set up an intolerable smoke nuisance, and although smoke was avoided by spraying upon fire-brick the costs did not compare favourably at the price then obtaining for oil fuel. The adaptation of boilers designed to burn coal to the burning of liquid fuel appears to require more preparation than can be given at short notice.

Steam remains incomparably the chief form of power used in textile industry, and by reason of its low cost and flexibility is still the favourite. Electricity extends gradually in the weaving departments and in cloth finishing, where work is of a more or less intermittent character, and the direct coupling of motors to the machines permits of certain economies. Where the load is constant, as in the spinning trade, electricity presents most advantage to the tenants of crookedly designed mills. The common calculation is that to compete in price with steam in a "straight line" mill current needs to be raised at ·3*d.* per unit, which is materially less than the ordinary charge for a municipal supply. Suction-gas engines have worked with admirable economy in some weaving sheds, but they are not generally regarded as being as free from the risk of breakdown as the steam engine, and they do not supply heat. A silk-weaving manufacturer finds his separate cost of heating the premises as great as that of driving his looms from a producer-gas engine. For occasional auxiliary power even the water-motor, driven by main pressure, is not wholly unknown in mill use.

The reactions of the coal strike upon the future of industry have been of less concern than the immediate effects upon trade. In satisfaction of existing orders the machines have more or less continuously been turning out goods, but in the home market there has been a paralysis of distribution. On general grounds it may be believed that distributors, both wholesale and retail, have made smaller preparations than last year and carry smaller stocks. The commercial travellers have been off the road since the first week of March in most instances. Drapers in the industrial parts of the country are in contemplation of a ruined Easter trade, and wholesale warehousemen are inclined to expect a hurried demand for supplies relatively late in the season. The expectation leads them to hopes of clearing old stock, and of picking up new goods when wanted rather than to any placing of new orders. Dismal as are the immediate effects of the strike calamity, there are ulterior difficulties within the reach of foresight. Textile materials have hardened rather than softened in price during the disturbed period, but both of cotton and wool there are extraordinarily large supplies.

"Bembergised" Wool.—A process strikingly akin to that which takes its name from John Mercer has been developed on a commercial

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scale in Germany. Mercer, in 1850, took out his patent covering the action of alkalies upon vegetable fibres, and nearly half a century later mercerised cotton, under its own name and a medley of fancy names, became a conspicuous article in the market. Mercerised cotton took the place of silk for stripes and checks in weaving and for crochet, embroidery, and fancy work. Mercerised cotton handkerchiefs, under one invented name or another, are in all the shops, and mercerised cotton linings have nearly driven out worsted and cotton lining from factories where cheap garments are made. Cotton cloth mercerised, dyed, and schreinerised (*i.e.* pressed between rolls engraved with fine lines) assumes the sheen of silk. The effect is due to a restraint of the change normally caused by immersing cotton in a caustic soda solution. The alkali operates to shrink the cotton, and its contraction is prevented by mechanical tension. Cellular strains are set up within the fibre and the cell walls collapse, so presenting an increased number of surfaces reflecting light. The cotton, if thoroughly neutralised and washed, gains strength, and it acquires an enhanced affinity for dye-stuffs.

The process patented by Elsaesser, and called "bembergising" by those who have developed it, applies to wool instead of to cotton. Worsted yarn of comparatively poor lustre is treated with bisulphite of soda at a high temperature, and the tendency to shrink is counteracted. The treatment is continued until the thread exhibits a stringy, gelatinous elasticity, and ends with boiling in an acid solution and a final washing. Mercerising cotton increases the length to a nominal extent, but "bembergising" stretches out worsted by 33 per cent., reducing it in diameter and also in twist, but not in strength. The lustre is highly enhanced without causing harshness of touch. The departure from the ordinary means of improving the lustre of wool is a marked one. Hitherto the methods in use have been rather physical than chemical, and have consisted chiefly of the use of water, heat and pressure, coupled with methods of removing protruding fibres obstructive of the reflection of light.

Rainproof Cloth.—There is evidence on every hand of the popularity of the raincoat, which has so largely replaced the rubber macintosh. High prices for rubber and too free resort to unsatisfactory rubber substitutes explain the discredit into which the cheap macintosh has fallen. Porosity, cheapness and some other virtues account for the ubiquity of the rubberless rainproof. The cheapest kind of double-fabric waterproofing with rubber and its substitutes is understood to cost 1*s.* 6*d.* a yard; which sum will pay for rainproofing twelve yards. The rain- or shower-proof treatment is not new, and this is not the first burst of popularity the raincoat has enjoyed, but the details may be stated for any interest they possess. Cloth intended for raincoats is treated in continuous machines, which impregnate the fabric thoroughly with acetate of alumina. The chemical, although highly soluble in water, and hence evanescent in its effect, itself markedly improves the original resistance offered by the cloth to the passage of water. Coming out of the series of baths in which the impregnation takes place, the cloth is dried more or less effectually by suction and heat. It thereupon receives a coating of wax, usually compounded of paraffin wax of high melting-point and some harder waxes. According to one system the wax is applied frictionally and dry; in another the wax is melted and applied in an infinitesimally fine film from the face of a small roller. The wax is a separate rainproofing agent, and it helps to lock the soluble chemical within the fibre.

Cotton, silk, linen, and wool are treated substantially in the manner described, and not always for coat-makers. Tent-cloths, awnings, and sail-cloths are sometimes rainproofed; balloon and aeroplane fabrics are 'proofed to prevent the development of mildew from wetting. Even tyre fabrics for motor-cars, and rugs destined to be lined with a rubber film, are first given this upper form of protection. The habit of riding in covered vehicles has reduced the necessity for wearing wind- and watertight overcoats, and the fact has been presumed upon. A dozen years ago the name "rainproof" fell into undeserved disrepute when thousands of pieces of cloth, which had undergone no efficacious rainproofing process, were stamped with the word "rainproof" and sent out to disgust the public. This second or third rise of rubberless rainproofing into general favour is also the highest that has been known, although an end to its popularity was confidently predicted for last year. Something is to be credited to a relative absence of deception, and something to the skilful and spirited advertising of certain tailoring firms. Flexible felt hats treated with acetate of alumina, and rainproof straw hats sprayed with a celluloid varnish, are the new concomitants of the rainproof coat. The hard felt hat is protected by its shellac. The silk hat defies the rainproofer by presenting a pile which lies in the direction of the weft, instead of following the warp as in other plush fabrics, and is consequently not eligible for treatment in his continuous machines.

CORRESPONDENCE.

THE INDIAN CENSUS.

A remark I let fall in the discussion of Mr. Gait's paper seems to have been understood to be a general depreciation of the value of mathematics in census work. I merely wished to point out that for the administration of the operations, *district* experience was the essential qualification, and mathematics only came in at the later stages. The Census Commissioner, for instance, cannot adequately handle his figures unless thus equipped for analysis and co-ordination. J. A. Baines.

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NOTES ON BOOKS.

SEA FISHERIES: THEIR TREASURES AND TOILERS. By Marcel A. Hérubel, Doctor in Science and Professor at the Institut Maritime. Translated by Bernard Miall. London: T. Fisher Unwin. 10*s.* 6*d.* net.

"The French mind loves generalisations; it would rather have erroneous generalisations than none at all." This admission on the part of its author suggests at once the strength and the weakness of this book. Of generalisations there are plenty, in fact, too many in it. Most of them are sound; some are premature; others are extremely debateable. Unfortunately, also, there are some considerable inaccuracies in the parts of the book which refer to the North Sea. But although not altogether reliable in regard to certain specific questions, it is certainly the most comprehensive and most luminous book on the subject that has yet appeared. Written chiefly in the interests of the French industry, it deals with all sea-fishery problems of vital importance to European nations in general and to Britain in particular; the supremacy of our country in regard to sea-fisheries being still unquestionable, although it is somewhat disquieting to read that "for one step taken by the French, the English take fifty and the Germans a hundred!" All the more reason why some of us should take the subject seriously to heart and try to understand it.

In the first section of the book the results of oceanographical and marine biological research are rendered intelligible to non-specialists and brought into touch with the realities of fishermen's lives. The bearing of a scientific knowledge of the sea on the important questions of depopulation and repopulation of the fishing grounds, is clearly shown. We are still far from anything like a complete and concise expression of natural law in the marine world. Instead of comprehensive formulæ we have a number of incompletely coordinated facts and ingenious hypotheses, which may or may not turn out to be correct theories. Any attempt, then, at a synthesis in the present state of our knowledge implies a good deal of premature generalising, as when the author speaks of several races of herring and plaice in the North Sea. We do, however, already know a certain amount regarding the biology of certain important fishes, their habits, their reproductive powers, their spawning grounds, their ages and rates of growth. We can, in the case of a few fishes, distinguish with a fair degree of probable accuracy spawning migrations and feeding migrations, and we know something as to the extent, direction, and rate of their movements. We also know a good deal about the chemistry of production in the sea; about the qualitative and quantitative distribution of the "plankton," that heterogeneous congeries of generally minute and often microscopic plants and animals which float in the upper layers of the sea and are present everywhere; about the seasonal changes in that part of the Gulf Stream circulation which affects and profoundly influences the fisheries as well as the climate of Western Europe. We know a good deal but not nearly enough about these things. We probably know enough, however, to justify Professor Hérubel in most of his generalisations and to support, for instance, his definition of fishing-grounds as "regions in unstable equilibrium, where there is an encounter of two critical conditions, one biological and the other oceanic."

When, however, it comes to applying this incomplete scientific knowledge of the sea to the practical solution of the problems of depopulation and repopulation, generalising, to the extent to which Professor Hérubel indulges in it, becomes a rather precarious pastime. One can agree in a tentative way with some of his conclusions, such as the following: "As for herring, cod, mackerel, sardines, sprats, and whiting, take them when and where they may be found; but give soles, turbot, and brill* the time to grow. They will never go far from the shore; you can always find them again." The second part of this statement is sound, but one cannot be *quite* certain that the first is. Again, while one is quite prepared to believe in the local utility of artificial coastal reservoirs for sea-fish such as are to be found on the coast of Brittany, in the fish-ponds of Arcachon and the lagoons of Venice and Commacchio, it is another matter if we are asked to share the author's evident, though not, it is true, definitely expressed, sympathy with the wholesale closure of inshore areas such as the Moray Firth.

But Professor Hérubel is on still more dangerous and dubious ground when he maintains that the small inshore or longshore fisherman is "the chief sinner" as regards the destruction of immature flat fishes. Evidently the Professor is insufficiently acquainted with the plaice fishery in the North Sea and with the data which have been published regarding it, or he would not have made this—so far as the small fisherman is concerned—damaging statement; for it is almost certainly the steam trawler in the offing, whose efficiency Professor Hérubel admires so much, that does most damage, since it captures the immature plaice just at the period when they are increasing most rapidly in market value. How the case stands in regard to soles and turbot is at any rate a matter on which it is only fair to suspend judgment, for the evidence merely of large *numbers* of small fry being destroyed largely misses the point. There is, however, another and more general way of regarding the question. The inshore fisherman on a small scale has been with us for centuries; in fact until comparatively recently—in the historical sense—he was the *only* kind of fisherman. But at the time when trawling on a big scale commenced in the North Sea, about the middle of last century, the fishing grounds were thick with large plaice, and "fortunes" were made by the discovery of great accumulations of soles in certain parts of the North Sea. Such

* Why not plaice?—Reviewer.

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fortunes are impossible to-day; the "accumulated stock" has long been fished out, and signs of an "overfishing" of the "current stock" have appeared in a decrease in the *average size* of plaice on the fishing grounds and in a general scarcity of soles. It is difficult to see how the small fisherman figures as "the chief sinner" in this description of the historical course of events.

Several errors in statements of fact have crept into the passages in this section which refer to the North Sea. Thus it is erroneously stated (table, p. 47) that the plaice spawns in May and June; and the flounder is classed with sturgeon and salmon as a fish which seeks rivers in which to spawn (footnote, p. 25). In another footnote (p. 24) some remarks on the distribution of the younger and older stages of the sole are stated to "apply to all flat fishes," which they certainly do not. They do not apply, for example, to that important flat-fish, the plaice. Again, Professor Hérubel is quite in error in maintaining that the catch per diem of plaice in the North Sea has steadily decreased during the last few years. His comparison of two selected years, 1903 and 1906, is obviously quite inadequate in this connection. The author's account of Professor Garstang's transplantation experiments is also misleading. He quotes M. Cligny to the effect that "the plaice taken from the Danish coast and transplanted to the Dogger seem to have grown normally, despite the length of transport." What actually occurred, as described in an English blue book, was that the fishes transplanted from the Danish coast to the "Tail End" of the Dogger grew normally, but those transplanted from the same coast to the "Shoal" of the Dogger underwent an abnormal increase equal to that exhibited by plaice transplanted to the same part of the Dogger from Bridlington Bay.

It is especially in this section that one notices not a few samples of singularly unhappy rendering into English of words and phrases. Thus Professor Hérubel is made to speak of the "emptying of the North Sea," when what he means is the progressive and rapid depopulation of that sea. Obviously "empty" is employed in the wrong sense here, apart from the exaggeration of the underlying thought. In another place we read that an "explanation is too systematic to be complete." Evidently "systematic" is not the right word. Neither are "azote" (for nitrogen), "anfractuous," and "enounce" current coin of language. These defects in the translation and errors in the original ought not to have been allowed to survive the final proof-reading, and their publication might easily have been avoided had the proofs of the book been consigned for revision to some competent English expert on sea-fishery matters, possessing a knowledge of the North Sea and, incidentally, of what constitutes good English as well.

The second section of the book deals with the sea-fisheries of France in particular and Europe in general from the standpoint of production. In this part of the book Professor Hérubel goes carefully and critically into all the principal questions relating to boats, fishermen, and fishing ports; into all the machinery of production and the details of organisation; into the relations of capital and labour, total production, and distribution of profits. He displays the inferiority, the relatively unprogressive character of the French industry as compared with that of Britain, Germany and other European countries. In the following striking passage the relative positions of France and Britain are very concisely stated:—

"The number of sea-going fishermen in France is about 100,000. Great Britain possesses about the same number. There is also in France a population of some 60,000 ashore—men, women, and children—actively engaged in the fishing industry. If we take the average figures of the season's fishery in France—namely, 191,600 tons of fish, and £4,400,000—we find that each fisherman is responsible for an average of two tons of fish, each ton being worth about £22 16*s*. The profit per man, in round figures, is £46. The English fisherman produces considerably more. The total average catch amounts to 958,000 tons, worth £10,120,000. In other words, the English fisherman is responsible for an average annual catch of 9·58 tons of fish, each ton being worth about £10 11*s*. 2½*d*., so that the yield per man is roughly £101 per annum. In other words, the British fisherman catches nearly five times as much as the French fisherman, and, although he sells it at less than half price, he gains more than twice as much as the French fisherman. As, like all industries, and all branches of organised commerce, fishery is one of the forms of the universal striving for gold to assure the worker of food and drink, we may assert that the economic inferiority of the French fisherman arises from the defective organisation of the French fisheries. The sea belongs to everyone; it is not enough to know it, to be reared by generations of sea-going ancestors, to be cradled within sound of the sea, and lulled by the murmur of its waves; the sea must be exploited as though it were a meadow, a field, a coal-pit, or a mine. Nature does not give; she sells."

What is wrong with the French industry, according to Professor Hérubel, is that there are too many small fishermen and too many small ports; too many sailing boats, and too few steamers and motor craft; the fishermen are not enterprising and educated enough; the State administration, like the boats, is antiquated and effete; and the toll of the middleman and the Customs dues are out of all proportion to the gains of the fisherman. "I would represent the French fisherman as struggling with two men who are trying to strangle him, while a third strews impediments in his path. The two first are easy to recognise—the *octroi* and the middleman—and the third is the railway." Though the metaphor is, perhaps, a trifle mixed it is vivid enough.

The model which Professor Hérubel holds up for the imitation of the French industry is the

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British industry, and especially the steam-trawling industry as carried on, for example, at Grimsby. For the businesslike way in which Grimsby disposes of fish our author has unbounded admiration. He apparently thinks that the mere inshore fisherman is a poor creature compared with a member of a crew of a steam-trawler. Whatever the conditions may be in France, there is surely something in this country to be said for the inshore fisherman. For one thing he is less specialised and, therefore, a more complete and healthy character than the steam-trawlersman. It is scarcely conceivable that the best interests of the nation would be served by the suppression (Professor Hérubel does not indicate how this is to be brought about) of a set of men who possess such pleasant traits of character as do our longshore fishermen; traits of character which it is a matter of common knowledge are not possessed in anything like the same degree by the average steam-trawlersman. Professor Hérubel is so rapt in admiration for the industrial efficiency of Grimsby, that he does not mention the other side of this flourishing port; its ugliness, its mean streets, and sordidness. If one would look at the question from the broad human standpoint, and not merely in the cold light of scientific admiration for industrial efficiency, this other side of the question must be taken into account. Anyone who has compared Grimsby with, say, Flamborough, Aldeburgh, or Sidmouth from this standpoint, will appreciate the force of this criticism. The ultimate disappearance of the fishing village may be inevitable, in many cases it is an accomplished fact; but it is none the less deplorable in the opinion of those who prefer to think of men, however poor, leading healthy lives in pleasant places. If, as has been already suggested, he does not do the damage with which Professor Hérubel credits him, is there any valid reason why the protection of the inshore fisherman should not go hand in hand with the development of steam-fishing on the large scale? Whatever the ultimate solution of this problem may be, there can be no doubt that this and similar questions are of vital interest to a nation whose 100,000 fishermen place over £10,000,000 worth of fish on the markets every year.

In spite of the inevitable human interest attaching to everything connected with the sea, with the lives of the fishermen on it and of the fishes in it, to write a really interesting and readable book on a subject so replete with facts and figures as sea-fisheries; to write with equal facility and understanding on such diverse and apparently unconnected subjects as, for example, marine biology and maritime insurance societies, is an achievement which implies, amongst other qualities, a comprehensive grasp of the whole situation and uncommon powers of generalisation and of exposition. This, however, is what Professor Hérubel has done. He has put an extraordinary amount of life into this mass of facts and figures, and has written an almost brilliant, although not infallible, work, WILLIAM WALLACE.

GENERAL NOTES.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.—Progress has been made in arranging the programme of the Eighth International Congress of Applied Chemistry, which will be held from September 4th to 13th, 1912, the opening meeting being at Washington, and the other meetings, business and scientific, in New York. The University of Columbia has placed at the disposal of the Congress whatever of its rooms and buildings may be required for the business of the meeting, while other accommodation will be provided by the College of the City of New York. The announcement contains provisional lists of the cities and industries that may be visited, rules for the presentation and publication of papers, particulars of steamship accommodation, rates, etc. Particulars and tickets of membership may be obtained from Professor M. O. Forster, Treasurer of the British Organising Committee, 84, Cornwall Gardens, London, S.W.

NATIONAL COMPETITION, 1911.—The report of the Board of Education on the National Competition has been issued. In all 13,153 works were submitted from 349 schools and classes. Of these 12,554 came from centres in England and Wales, 56 from Scotland, 489 from Ireland, 9 from Jersey, and 45 from New Zealand. In a large majority of the classes the examiners report very favourably on the work submitted. Ten gold medals, 102 silver medals, 261 bronze medals, 560 book prizes, and 991 commendations were awarded.

MEETINGS FOR THE ENSUING WEEK.

WEDNESDAY, APRIL 10...Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Professor Morgan, "Paraffin as a Fuel."

THURSDAY, APRIL 11...Architects, Society of, 28, Bedford-square, 8 p.m. Discussion on "The Ethics of Architectural Practice."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m.

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. A. Mitchell, "The Scientific Examination of Documents."

Automobile Engineers, 13, Queen Anne's Gate, S.W., 8 p.m. (Graduates' Section.) Mr. E. D. Suggate, "Lubricating Oil."

Mathematical, 22, Albemarle-street, W., 5.30 p.m.

FRIDAY, APRIL 12...Malacological, in the Rooms of the Linnean Society, Burlington House, W., 8 p.m. 1. Mr. A. J. Jukes-Browne, "The Genus *Dosinia* and its Subdivisions." 2. Mr. E. A. Smith, "On the Generic Name to be Applied to the *Venus Islandica Linn.*" 3. Mr. Henry Suter, "Note on *Lapparia Parki.*" 4. Mr. H. B. Preston, "Characters of Three New Species of Freshwater Shells from Uruguay. New Species of *Limicolaria* from British East Africa."

British Foundrymen's Association (London District), Cannon Street Hotel, E.C., 8 p.m. Mr. G. Hailstone, "The Application of the Microscope in the Foundry."

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Journal of the Royal Society of Arts.

No. 3,099. VOL. LX.

FRIDAY, APRIL 12, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

WEDNESDAY, APRIL 17th, 8 p.m. (Ordinary Meeting.) JOHN HENRY COSTE, F.I.C., "Municipal Chemistry." DR. RUDOLPH MESSEL, F.C.S., President of the Society of Chemical Industry, will preside.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, March 26th, 1912; EARL BRASSEY, G.C.B., in the chair.

THE CHAIRMAN said he felt the deepest interest in the subject with which the author was about to deal, and that interest was all the more keen because he had himself been a traveller in Borneo. It was a full credential in Mr. Lovegrove's favour that he was in the service of the North Borneo Company, that he had been in their service for thirteen years, and that he was one of the treasurers of the local administration. To say that was to give the meeting an assurance that Mr. Lovegrove thoroughly knew the country, and that he was able to give information which was certain to be of the deepest interest.

The paper read was—

BRITISH NORTH BORNEO.

By LEONARD LOVEGROVE.

British North Borneo is the northern part of the island of Borneo, and is owned and administered by the Chartered Company of British North Borneo, known here as the British North Borneo Company, and in the Far East as the British North Borneo Government. The boundaries conterminous with Brunei and Sarawak have been delimited. The sea boundary contiguous to Dutch Borneo has also been settled by means of beacons. The inland boundary has as yet only been fixed by latitude, but I hope and expect that it will be marked out very soon. At present the District Officer of Rundum very often is not certain whether he is in our territory or in Dutch Borneo when he is travelling about his district. Our nearest inland police-station to the boundary is Sibungo, and difficulty is experienced in punishing head-hunters and other evil-doers when one is not certain whether they are British or Dutch subjects. Moreover, some of our jungle produce finds its way into Dutch Borneo by rivers which flow into the sea in Dutch territory, and have their source in ours.

HISTORY.

It appears that in the early days the British nearly missed obtaining any foothold in Borneo, but an outbreak of war in Java caused Borneo to be more or less neglected by the Dutch for a considerable period, no effective check being imposed upon the natives with a view to stopping piracy, and the position daily becoming more and more unendurable. On the rise of Singapore direct trade had been established with Sarawak and Brunei, and it became a matter of moment to British merchants that this traffic should be conducted in safety. In 1838 Sir James Brooke, whose attention had been turned to the state of affairs in the Eastern Archipelago, set out for Borneo, determined, if possible, to remedy things. By 1841 he had obtained from the Sultan of Brunei the grant of supreme authority over Sarawak, in which State, on the Sultan's behalf, he had waged a successful war, and before many years had elapsed he had, with the aid of the British Government, succeeded in suppressing piracy. The island of Labuan was occupied by the British as a Crown colony in 1848, and this may be taken as the starting point of renewed British relations with that portion of Northern Borneo to the north of Brunei. In 1872 the Labuan Trading Company were

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established at Sandakan. They imported a few Chinese, but did not prosper very much. As long as the money was remitted the agent there was able to carry on. After they retired their rights were transferred to a small syndicate, including Lord Redesdale and one or two others, and two or three years afterwards re-transferred to Mr. (now Sir) Alfred Dent and Mr. E. Dent, who sent out Baron von Overbeck to enter into further treaties with the Sultans, with the assistance of the late Mr. W. C. Cowie. Three officers were despatched—Mr. Pryer, Mr. Pretyman, and Mr. Leicester. They were there all alone amongst the natives, and it is very interesting to read their original letters. The natives were very glad to see them. They had been accustomed to be robbed by the chiefs, and they were made slaves; but all that soon changed. After this application was made to the Government for a Charter. There was a long delay over that. Lord Salisbury's Government looked favourably on the matter, but meanwhile they went out of office. Then Mr. Gladstone's Government came in, and after about four years a Charter was given. A small Provisional Association was formed with the assistance of Sir Richard Martin, Sir Rutherford Alcock and others. The Charter was finally given in 1881. The British North Borneo Company was formed in May, 1882, and proceeded under its Charter to organise the administration of the territory. The Company subsequently acquired further sovereign and territorial rights from the Sultan of Brunei and his chiefs in addition to those already obtained; and to-day there are no independent rivers or districts in our territory. The independent rivers were a source of trouble to us, as the people evaded our customs duties, and we were glad, for many reasons, when they were all acquired. In 1888, under an agreement between Her late Majesty's Government and the Company, the territory became a British Protectorate, but its administration remained entirely in the hands of the Company. The Crown, however, controls the foreign relations of the State, and the appointment of its Governors requires the formal sanction of the Secretary of State for the Colonies. In 1890 the British Government placed Labuan under the administration of the Company, the Governor of the State of North Borneo thereafter holding a Royal commission as Governor of that colony, in addition to his commission from the Company. This arrangement held good until the beginning of 1906, when Labuan was attached to the colony of the Straits Settlements.

The total area of the Company's territory is estimated at about 31,000 square miles, with a coast line of over 900 miles. The greater portion is exceedingly hilly, in parts mountainous, and the interior consists almost entirely of highlands, with here and there open valleys and plateaux of fifty to sixty square miles in extent. On the west coast the mountain range runs parallel with the seashore at a distance from it of about fifteen miles. Of this range the central feature is Kinabalu, which is composed of granite and igneous rocks, and attains to a height of 13,698 feet. Three ascents of this mountain were made during 1910. One of these ascents was made by Miss Gibbs, accompanied by Mr. Maxwell, district officer, the chief object being botanical research; another was by Dr. Fosworthy, who, I believe, is an American. The third ascent was made by a scientific party, consisting of Captain Learmonth and Lieutenant Harvey, of H.M.S. "Merlin" (one of the ships which have been surveying all round the bays and harbours of the territory), Mr. R. W. Clarke, of the British Borneo Exploration Company, Mr. Scott-Browne, and Mr. H. W. L. Bunbury, district officer. They had a most interesting trip, although the summit was covered by a mist many of the days they spent on the mountain. They were able to establish communication by heliograph with Jesselton, on the coast. It is impossible to sleep at the very top, there being no suitable place, so the highest camp is a cave, from which day ascents to the pinnacles can be made. Mount Kinabalu is quite one of the sights of British North Borneo. To be seen to advantage it should be viewed from the west at dawn of day, and watched until it is wrapped in the vapour drawn up from the lower grounds as the sun gains power. I have seen it very clearly about 5.30 p.m. from Jesselton without any mist overhanging it. Mount Madalon, some fifteen or twenty miles to the north, is 5,000 feet in height, and inland across the Pagalan Valley, which runs through the Tambunan country, and falls into the Padas River, rises the peak of Trus Madi, estimated to be 11,000 feet above sea-level. The valley of the Pagalan is itself for the most part from 1,000 to 2,000 feet above the sea, forming a string of small plateaux marking the sites of former lakes. From the base of Trus Madi to the eastern coast the country consists of huddled hills broken here and there by regions of a more mountainous character. The principal plateaux are in the Tambunan and Kaningau valleys in the basin of

the Pagalan, and the Ranau plain, to the eastward of the base of Kinabalu. Plateaux of minor importance are to be found dotted about the interior. The proximity of the mountain range to the seashore causes most of the rivers in the west to be rapid and impeded by boulders. The Padas is navigable for light-draught steam launches and native boats for a distance of nearly fifty miles from its mouth, and smaller craft can be punted up as far as Rayoh, some fifteen miles further; but at this point its bed is obstructed by impassable falls and rapids extending to Tenom, where the water is smooth. As the railway runs from Beaufort to Tenom alongside the river, the latter is very little used nowadays. The railway has opened up the interior to the planters, and two European companies are operating in the vicinity of Tenom. There is room for more. The Kinabatangan is the largest and most important river in the territory, and its source is believed to rise eastward of the range of which Trus Madi is the principal feature. It is navigable by steamer for a considerable distance and by native boats for over 100 miles from its mouth. Valuable tobacco land, which, however, is somewhat liable to flood, and remarkable burial caves are found in the valley of the Kinabatangan. Several of the natural harbours of North Borneo are accessible, safe and commodious. Sandakan harbour, on the north-east coast, runs inland for some seventeen miles, with a very irregular outline, broken by the mouths of numerous creeks and streams. The mouth, only two miles across, is split into two channels by the little high bluff-like island of Barhala. The depth in the main entrance varies. I am afraid that there is not much over five fathoms anywhere on the bar. Silting has been going on by degrees, and this is now receiving the serious attention of the Court of Directors.

Sandakan is the capital of the State, although Jesselton, the first port of call on the west coast, is now nearly as important. Lahat Dato, on the east coast, is the headquarters of the Residency, which includes the country south to the Dutch boundary. Kudat, in Maruda Bay, first surveyed in 1881, was the original capital. There is a useful harbour here, and across the bay at Timbang Batu is water deep enough to take the whole Navy.

Revenue and Trade.

The revenue in 1900 was $587,227, in 1905 $994,330, and in 1910 $1,238,505, from which it will be seen that good progress has been made. These figures are exclusive of land sold and price paid for concessions of land. The chief items of revenue are the customs and the monopoly for the excise farms, which are run by a Chinese syndicate under the laws of the Government, a fixed sum being paid monthly by the syndicate to the Government.

The railway receipts in 1909 were $93,756; and in 1910 they had risen to $116,515, a very satisfactory increase. The value of the imports in 1900 was $3,178,929, in 1905 $2,836,676, and in 1910 $3,801,306. The exports in 1900 amounted to $3,326,621, in 1905 to $4,537,486, and in 1910 to $4,609,021.

As will be seen, our exports exceed our imports, which, of course, means prosperity. Included in the imports of 1910 are aerated waters. In future these will show a decrease, as we are starting aerated water manufactories. Cloth will always be a large item, the natives being ready buyers. Ironware and machinery are required by the estates and others. Opium is consumed by some of the Chinese.

Products, etc.

It is a pity that we have to import so much rice that might be grown in the country. Perhaps some day a wealthy Chinese Towkay or merchant will take the matter up; at present the natives plant only sufficient for themselves and a little over. The export of rice and paddy in 1910 was $13,253—probably mostly paddy. Coal of the value of $153,810 was exported in 1910. This is being worked by the Cowie Harbour Coal Mines, who have a storage at Sandakan also.

Cutch or catechu is a name common to several astringent extracts prepared from the wood, bark, and fruits of various plants. It is used as a dye, and most of it is shipped to New York.

Birds' nests are made by a small swiftlet, which selects caves, the larger and darker the better, for building in. The most valuable of these caves occur in limestone rocks. The nests are of two classes—white, and inferior or black. They are collected twice, and in some cases three times a year. The price given for the nests is very high, as they are a great delicacy in China for making soup. Natives who have a share in the caves rarely do any other work for that year, as they can always secure an advance of food and goods from the Chinese purchasers. The share is held in turn for a year by branches of a family, and is often the subject of litigation.

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Above the mangrove, and where the water begins to be brackish, nipa palms commence, and large swamps of them intervene between the mangroves and true land. From this nipa palm attaps are made for the roofs of houses. The estates use an enormous quantity for their coolies' quarters and drying sheds. Our export is not large, nearly all that is made being bought up immediately. Kadjan mats, also manufactured out of nipa leaves, are indispensable for travelling purposes, as they can be packed up in the smallest compass when not required. Each is capable of affording sufficient cover at night for two or three people, either in boat or forest journeys. They are also used for side-walls and partitions within cheaply built and native houses. The young nipa leaf, unfolded and dried, forms the favourite covering for cigarettes in preference to paper. Copra is the dry kernel of the cocoanut. It is in steady demand for the purposes of oil-making, etc. The refuse of the kernel, after the oil has been extracted, is used as manure, and as food for cattle and pigs; the husk yields coir for rope and mat-making.

Our export of coffee is very small, hardly anyone planting it at all, as it cannot compete with Brazil and other countries. This is to be regretted, for the Borneo-grown coffee is very good, as I am sure everyone will agree who has drunk it at the annual North Borneo dinner in London. Dried fish always finds a ready market, especially now with the plantation coolies. It is a good substitute for the fresh article, which is not always obtainable.

The india-rubber industry received an impetus in 1910, the quantity exported being 54,631 lbs. Sekong Estate accounts for 49,000 lbs. of this. The figures will show an enormous difference in the next few years. The Sekong Rubber Co., Ltd., realised 12*s*. 8*d*. per lb. for its rubber. This was the highest price at one time obtained. At later sales Borneo has again realised almost top prices. We lay great store by our rubber estates.

The rattan is the stem of a creeping prickly palm. The rattan saga is the ordinary rattan of commerce, but there are several others of more or less value known to the natives under various names. Other rattans there are which are utilised as umbrella handles, walking sticks, etc., and very handsome sticks they make.

The sago palm is of two kinds—one the spineless variety and the other the trunk of which is armed with long and strong spikes, which tend to preserve it when young from the attacks of the wild pig, which abound in all parts of Borneo. The palm attains a height of from 20 ft. to 50 ft., and grows in vast forests in swampy land along the banks of rivers not far from the coast.

What is known in Europe as sago is obtained in the shape of a fine white flour from the heart of the palm in the following manner: Just before the terminal spike of flowers appears, about six to eight years from the time of planting, the palm is cut down at the root, divided into lengths to suit the manipulator, and each length split in two, when the pith is scooped out by means of bamboo hatchets, a thin outside skin or rind being all that is left. The pith is placed on mats over a trough by the riverside, and water being constantly poured over it, is trodden out by the natives. A rough separation of the starchy from the woody matter is thus effected, the former running off with the water into the trough below, while the latter remains on the mat, and is thrown away or used as food for pigs. The sago, known then as Lamunta (raw) is sold to the Chinese, by whom it undergoes further cleaning by means of frequent handworking in troughs, and is then packed in gunny bags and exported to Singapore. There it is either converted into the pearl sago sold in the shops, or is sent direct to Europe as flour for use in sizing cloth, manufacture of beer, preparation of confectionery, etc. A full-grown tree is said to produce 200 lbs. to 300 lbs. of sago flour. This sago flour, boiled into a paste, is largely used as food in the place of rice in districts where it flourishes; in fact, I know some natives who prefer the sago to rice. On the other hand, many would rather have rice, but are unable to buy it, and are apparently too lazy to grow it when they have their sago just outside their door. If the palm is allowed to flower and seed, the pith of the centre is found to be dried up and useless, and the tree dies. The seeds are often unproductive, but each palm gives out numerous offshoots, which take the place of the parent tree, and in time leave a family of offshoots, so that a sago plantation once started practically "goes on for ever." Sago grows vigorously everywhere in suitable damp localities. The Padas River has many valuable sago plantations on both banks right up to Beaufort. In 1910 sago, like rice, suffered from lack of attention, a large number of workers having sought employment on estates. The life on the Estates seems to be much appreciated by some, affording, as it does, constant employment,

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decent pay, and regular hours. Certainly many are distinctly improved after a period of such work.

The timber trade of North Borneo has undoubtedly been very beneficial to the country. We have immense forests, which led to a trade with China, where they grow no timber at all practically. Two steamers are running regularly between Sandakan and Hong-Kong, taking away full cargoes of timber, including firewood. One steamer calls at Kudat and one at Tawao, on the south-east coast, when there is sufficient inducement. Most of the concessions taken up are on the east coast, where the more valuable forests are situated and where the timber is more easily worked, being near the mouths of rivers. There is good wood on the railway line between Beaufort and Tenom, but it has not yet been worked, except in small quantities for use on the railway. There were 159,965 more cubic feet shipped in 1910 than in 1909, and sawn wood is being exported to European ports by nearly every steamer for transhipment at Singapore. Some new Chinese firms are embarking in the enterprise of timber-cutting, and existing concerns are extending their operations. There are two sawmills under European management at Sandakan, and both are working to their full limit. The arrival of the rubber planters on the west coast was a great boon to the mills, as planks are always required on plantations.

Trepangs — a sort of sea-cucumber — are collected by the Bajaus or sea gipsies, who cure and dry them, and bring them to market. They are bought by Chinese traders, and sent ultimately to China, where they are much appreciated, being used to make soup. They vary considerably in price. Some, indeed, have no value at all, and go uncollected; others fetch as much as $25 a picul (133⅓ lbs.), but the usual price is from $10 to $15 a picul. Along the coast they are rather extensively collected; but amongst the islands and on the coast line down to the south there are immense quantities left untouched from year to year.

Rubber and tobacco are now the chief products, but there are signs of an awakened interest in cocoanuts. Para rubber is still the favourite kind, only a very few acres being devoted to other varieties. The system of clean weeding has been generally adopted in preference to the use of catch crops and weed-killers, except in the interior, where passiflora has been found successful. No serious outbreak of disease has been reported, although it exists in some fields. The managers, by treating those trees affected quickly, are usually able to restrict the area attacked. Work was started on seven new estates on the west coast during 1910. In all, at the end of 1910 there were twenty-nine estates planting rubber or tobacco or both.

Five estates confine their attention to cocoanuts, and one to pepper and gambier.

Tobacco was planted on twelve estates in 1910. The crop, on the whole, was reported as satisfactory. A total of 14,819 bales was exported, as against 15,672 bales in 1909. These figures for two consecutive years vary relatively according to whether part of a crop is shipped in December or January. The Sumatra leaf is rather finer than the Borneo one, owing, I am told, to the planters accommodating themselves to the American buyers. Of the finer leaf, weighing less, more can be imported into the United States under the Customs duty. The Borneo leaf, like that of Sumatra, is used chiefly as a wrapper, although pure Borneo cigars are on the market. The Borneo cigar, I am glad to say, is getting more and more into favour with the public, as the price is not exorbitant. On the east coast the seasons are more clearly defined, the wet season being from October or November until March or April. In and around Labat Dato on this coast are situated the concessions of the New Darvel Bay Tobacco Plantations, Ltd., who are usually able to make a very fair profit on their crops. Planting takes place in April or May, and in seventy days the leaves are gathered, so that three months only elapse from the time the seeds are put in the nursery beds until the gathering of the harvest. After the leaves are gathered they have to be hung in drying sheds, and thereafter they are placed in the fermenting sheds and baled for the steamer. The sales take place in Amsterdam by auction. The fields, about 1⅓ acre, are given out to what is called a field coolie, who is working under the advance system—that is to say, everything he takes in the shape of food or cash, etc., is charged to him. His crop is then taken over, and he is credited with the amount, so that he is always working for his own benefit, and this always appeals to a Chinaman. A good field coolie will often clear a net profit of $120—say £14, or even more.

Whilst on the subject of these plantations, I should like to say how much the directors and shareholders are indebted to their European staffs, from the managers downwards. It is impossible to give you an idea of the amount of work got through each day on a plantation, but I can assure you that it spells hard work for everyone. The tobacco companies work on

commission on a schedule to their European staff, which is a good plan, and an incentive to them all. No doubt the rubber companies will eventually adopt the same system.

Cocoanuts are steadily increasing. The cultivation is principally at present on the east coast. The export of copra in 1910 was nearly double that of 1909. The cocoanut palm flourishes everywhere in this region, inland as well as on the seashore, which is somewhat strange, as in many places there is a theory that sea air is a necessity for it. In the Philippine Islands groves of countless thousands exist far inland, bearing heavily and looking extremely healthy. The trees in North Borneo bear fruit much earlier than in most other countries, thanks to the suitability of soil and climate. A considerable number of trees in a grove should be beginning to bear at from four to five years of age.

As regards cotton, I quote from the speech of the Vice-Chairman of the company at the July 1910 meeting :—"The experimental stage of planting cotton, which has been carried on for some years, is now practically at an end. It has been abundantly proved that the soil and climate are admirably adapted to its cultivation, and samples sent to Hong-Kong and Japanese markets were favourably reported on. An estate for the cultivation of cotton would probably prove a financial success if operations were started in one of the more populous districts, where the labour of women and children for picking would be easily obtainable. It is a kind of cultivation that commends itself to the native mind, for it produces good results with the minimum expenditure of labour."

The growing of vegetables and fruit has received an enormous stimulus by the opening up of the new estates, and many fresh allotments have been taken up. The vegetable gardeners are chiefly Hakkas, whose wives all take their fair share in the daily duties. Breeding of pigs usually goes along with the vegetable and fruit garden, and pork is always saleable at a good price. All the vegetable gardeners, native and Chinese, are, I believe, doing very well.

The British Borneo Exploration Company have the sole right of mining granted them under certain conditions. Efforts have lately been confined to the copper pyrites on the Labuk River. This Company have their own geologist. Gold has been found in alluvial deposits on the banks of some of the rivers on the east coast, but the quantity available is doubtful. The territory has not been fully examined.

The Government have now started a labour-recruiting agency in China. No Chinese coolie can be imported into the country except through that agency, or under permit from the Government. This will reduce the cost of introducing labour, agents' fees, etc., and also guarantee that the right sort of coolie is brought in.

Climate and Population.

The climate of North Borneo is tropical, hot, damp, and, therefore, somewhat enervating. The rainfall is about 120 inches at Sandakan, whereas Beaufort on the railway has 144 inches. The lowest reported in 1910 was on the Sapong Estate, 63·07 inches, falling on 229 days. The shade temperature ordinarily ranges from 72° to 94° F. the average being about 86°. In the interior the days are considerably hotter, and one feels the power of the sun more, but the nights are cooler.

The population, as shown by the census of 1911, is 208,183, including 355 Europeans. In 1901 the total number of persons enumerated was 104,527, but the census in 1911 was taken in a more efficient manner. It is no easy task getting the information from some of the people who neither read nor write. The Chinese have increased by 13,720, and a very important part they play in the interests of the country—in fact, they form perhaps the most valuable element in the development of the territory. Sometimes they are apt, especially the coolie class, to take collective action in the form of secret societies, which have to be promptly nipped in the bud. The Chinaman is industrious, frugal and intelligent; the richer are excellent men of business and are particularly just in their dealings. The majority of all classes can read and write their own script, and the second generation acquires an education of a European type with great facility.

The missions, especially the Roman Catholic, turn out some really smart youths as clerks. The bulk of the shop-keepers are Chinese. One finds a small shop even in remote districts. The Bajaus used to subsist by fishing and collecting sea produce, and they chiefly lived in boats, but now they are finding that to work for Europeans is more profitable, and some of them will take on a contract for clearing and felling jungle, and supplying round timber to the estates. In fact, under our rule, the Bajau is proving himself a good workman, and is building up a permanent home, in place of leading the roving, piratical life he was formerly accustomed to. In appearance the Bajau is small, active, dark,

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with very bright, gipsy-like eyes, and straight black hair. As a body they are better looking than the Dusuns, or agricultural class, who accuse them, and very justly, of stealing their buffaloes and cattle. The Bajaus at the northern part of our territory have many ponies, which they ride fearlessly, spearing the great sambur deer while at full gallop. The Dusuns are the farmers of North Borneo. They number 87,951. They cultivate their land with *padi* and use ploughs. They also own cattle and buffaloes. In some of their villages they have married into Chinese blood, and the result is good. It seems to make them more industrious and frugal. It is quite a pleasure to walk through some of our model native agricultural villages, and see them all tending their crops, and the whole place properly irrigated. In this wet farming they use the same land year after year, and many of these native holdings have been demarcated, and the holders pay rent to Government. Now with the advent of the European planters their eyes are being opened to the fact that without a title-deed of some description from the Government they are apt to lose their land. One of the most important items in the work of the Land Office in 1910 was the settlement of native rights to isolated fruit trees, etc., when they were cut down by the rubber estates.

The Muruts number 25,314, and they are the people who, far away from civilisation, still indulge in head-hunting; as they advance in civilisation they will probably become Mohammedans. Their villages are very small, and often hidden far away in the jungle. A village sometimes consists of a single log hut divided up into cubicles, one for the use of each family, opening out on to a common verandah, along which the skulls captured by the tribe are festooned. The Muruts are probably the representatives of the aboriginals of the island. Both Dusuns and Muruts are too fond of the intoxicating liquor, which they manufacture from their corn.

The number of contract labourers imported during 1910 was 8,648, of whom 6,200 were Chinese, most of the remainder being Javanese. Medical examination of all these immigrants is compulsory, those being physically or mentally afflicted not being allowed to land. Most if not all of these labourers arrive with an advance outstanding against them, and for that they undertake to work a certain period, the advance being collected in monthly instalments—viz., by deductions from their pay. It is a bad system, but it cannot be avoided. A Malay or Chinaman does not appear to be, and, I believe, is not happy, unless he is indebted to his employer. A Malay is content to do a day's work for a day's pay, but a Chinaman prefers a fixed task where he can work more and earn more. The natives of the Sulu Archipelago, I see, have decreased by 870. These natives are related and intermarried with those of the Southern Philippines. They are fanatical and want very careful management. They have been a thorn in the side of the Americans in the Southern Philippines.

Administration.

For administrative purposes the territory is divided into nine provinces. The boundaries of these provinces are in some cases purely arbitrary, and not accurately defined. The form of government is modelled roughly upon the system adopted in the Malay States of the Peninsula. The Government is vested primarily in the Court of Directors which is appointed under the Company's charter, and may be compared to the Colonial Office in its relation to a British colony, though the Court of Directors interests itself more closely than does the Colonial Department in the smaller details of local administration. The supreme authority on the spot is represented by the Governor, under whom are the Residents of Sandakan East Coast, West Coast, Kudat, and the interior. Other districts are administered by district officers, who are also district magistrates, There are five treasuries, controlled by district treasurers, which is my department. Some of the heads of the departments are at Sandakan and some at Jesselton. I think it would be advisable in many ways to concentrate them all at Jesselton, which is nearer the cable and to Singapore, with which port most of our trade is done; at any rate, it requires consideration, as there are many interests of long standing bound up on the east coast. The Secretariat is under the charge of a Government Secretary, who ranks next in precedence to the Governor. The Government Secretary resembles the Colonial Secretary in a British colony, and his position is a most onerous one. In North Borneo we are fortunate in having men of the type of Mr. Pearson, who has just handed over the reins of Acting Governorship to our new Governor, Mr. F. R. Ellis, C.M.G., late of the Ceylon Civil Service.

Legislation is by proclamation of the Governor, but there is a council composed of the principal heads of departments and one unofficial member, which meets at irregular intervals. The Governor

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is the chief judge of the High Court to hear appeals. Then there is the Sessions Court, administered by the Judicial Commissioner, and the Residents of districts are also Sessions Judges. The magistrates are divided into three Courts—first, second, and third—and their powers are defined by the Indian Procedure Codes and by local laws. The Headman's Court looks after native cases, with a limit as to jurisdiction. The Mixed Court, consisting of two native chiefs and one European magistrate, is a very useful tribunal for dealing with cases which the magistrate could no doubt settle himself, but which for political reasons he thinks should also be adjudicated upon by headmen.

The native chiefs are responsible for the preservation of law and order in their districts.

The Constabulary number seven officers and about 700 of other ranks; the nationalities include, besides British officers, the following: Sikhs, Pathans, and Punjabi Mohammedans, Chinese detectives, Malays, Dyaks, Filipinos and natives of the country. A criminal registry has been started, the finger-print system being adopted in the case of all vagrants and persons charged with offences punishable with imprisonment up to one year, or fine extending to $1,000.

Government gives a capitation grant to the three missions—S.P.G., Roman Catholic, and Basel. The S.P.G. have three stations, the Roman Catholics four, and the Basel four. There are eleven Chinese schools, with an aggregate of about 250 pupils. These schools are annually inspected by a Government officer. The Chinese have their joss-houses and the Mohammedans have their own mosques.

Finance, etc.

The principal sources of revenue are the excise farms previously referred to—they are in the hands of Chinese syndicates at present —the Customs inwards and outwards, poll-tax sanctioned by ancient native custom, and stamp duty. Revenue is derived from the rent on Government lands sold, transfer fees, etc. Judicial fees bring in a small amount, and the issue and sale of postage and revenue stamps has proved a fruitful source of income. The people of the country are by no means heavily taxed. A large number of the natives of the interior escape all payment of dues to the Company, the revenue being for the most part contributed by the more civilised members of the community residing in the neighbourhood of the Company's stations. I should like to add that there will be no export duty on rubber for fifty years from April 1st, 1905. There are bank agencies at Sandakan and Jesselton, and the Company does banking business if required. The State, which has adopted the penny postage, is in the Postal Union, and money orders and postal orders payable there are issued in the United Kingdom and in most British colonies, and *vice versa*. There is a Government note issue for use within the territory only. The currency is the Straits dollar, valued at 2*s.* 4*d.* by the Straits Government, although the bank rate is very slightly higher or lower according to whether the banks are buying or selling drafts on London. The Company has its own copper and nickel coinage. In the interior the principal medium of exchange among the natives is the large earthenware jars, imported originally, it is believed, from China, which form the chief wealth both of tribes and individuals.

The bulk of the trade is with, or through, Singapore, and is carried almost entirely by the North German Lloyd steamers. A Chinese firm of Singapore started a cargo steamer or two, but abandoned the enterprise. The timber trade is mostly with Hong-kong, and is carried by one North German Lloyd and one British steamer. These convey, in addition, copra, cocoanuts and sundries, bringing back kerosene oil and manufactured goods. Interport trade is carried on by the Sabah S.S. Co.

Sir West Ridgeway, Chairman of the Company, has quite recently paid a visit to the country, and has, no doubt, conferred with the Governor on many points, and prepared a programme for further developments. Progress has been constant, and the country is quite different from what it was when I first went out in 1898. The communication and mails were then so irregular that no one knew when they might arrive or when they might depart. Jesselton as a port of call for Singapore steamers was then unknown. A captain said, "I believe there is some little place behind the island, but we do not go in there." He meant the island of Gaya, which forms the protection for Jesselton, and the little place he referred to was, if I remember correctly, Gantian. We now have three steamers running regularly between Singapore and our ports, all time-tabled to fit in with the German mail vessels homeward and outward bound, and I believe the N.D.L. think of putting on a fourth vessel.

[A large number of kinematograph views of British North Borneo, recently taken by Mr. Cherry Kearton, were exhibited and described by him.]

DISCUSSION.

The Chairman, in proposing a hearty vote of thanks to the author for his admirable paper, and to Mr. Kearton for the views he had shown, said that the taking of the kinematograph views was a marvellous achievement in view of the difficulties which Mr. Kearton must have encountered in obtaining the pictures, which enabled the audience to realise, as they could never have realised otherwise, that far-away dependency of the Empire. Personally, he felt the greatest interest in North Borneo, having had the advantage of visiting the coast and knowing something of the inhabitants. He had had the privilege of sitting for a time on the Board of the British North Borneo Company, and he was able to contrast the existing condition with that which obtained many years ago. The progress had been wonderful. He remembered the beginning in the first days under the advice of, among other people, that gallant sailor Sir Harry Keppel, and the idea then was that North Borneo was to be a power by sea, and that they were to have a vessel of war powerfully armed and well manned. That vessel more than exhausted all their resources. They were obliged to abandon the ambition of maintaining a navy, and to rely upon the Imperial forces for their protection, and they had to do what they could with their resources in the development of the country. Matters did not advance very quickly. There were brave and capable people out in Borneo when he was there, but nothing had presented itself at that time which gave much promise. There was a timber company, and he remembered that, before leaving, he thought that he ought to make some return for all the kindness that had been shown to him by trying to do something for the development of the country. Under the advice of a then resident he put a certain sum into a timber company. The company had a bad time for many years. They were too ambitious. But he was glad to say that things were mending at last, and that, as they had heard from Mr. Lovegrove, important changes had taken place, and there was traffic between the Borneo forests and the market of Hong-Kong. Besides this, a good deal of that fine timber pavement which was laid down in London came from the part of the country which produced hard wood. A change had come over the spirit of the dream. He believed that the first windfall for North Borneo was the discovery and the use of a tobacco of very superior quality. The cultivation was, however, attended with some difficulty, as so often happened in tropical countries. When the soil was first broken up a miasma arose which was fatal to life. There was much suffering, and various unhealthy conditions prevailed in the beginning of the cultivation, but finally the tobacco industry was successfully established in North Borneo. Then they had come in later days to the rubber industry. That was a very striking and interesting subject. There were comparatively few persons who had sufficient fortitude to resist altogether the temptation to make a little plunge into rubber, and there had been varying results. He only hoped that those who had made the plunge in Borneo would be well rewarded for their enterprise. Then it had been found that the Chinese were, as was now known, a most suitable people for opening up a country. It was very interesting to hear how much the natives could do for themselves. That was a marvellous climbing feat shown in one of the pictures in which the man went up the tree for cocoanuts. The copper mining shown in the pictures was remarkably like the best practice among English people. Borneo was a specimen of what was achieved all over the world. The position which had been reached by their own little island with its small resources was marvellous, but it would not have been attained unless Englishmen had been enterprising in opening up countries far and wide over the surface of the earth. North Borneo could not be compared with the greatest dependencies which Great Britain had in the tropics, but it was typical of what our brethren were doing beyond the seas. Large and deep should be the gratitude which those who lived at home at ease ought to feel to the men and women who went forth as pioneers and endured all the hardships and strain of a tropical climate, carrying more or less their lives in their hands, and who by their labour built up the greatness of the Empire.

Mr. Edward Dent thought that one feature which was very satisfactory about Borneo at the present time was the increase among the natives. Papers which had been read before the Society in former days—one by Mr. Francis Cobb in 1834, and one by Mr. Henry Walker in 1903—showed that the population of Borneo was far greater formerly than it was at the present time. The population had decreased very much in consequence of small-pox, head-hunting, and other causes. Mr. Pryer, who was one of the first Englishmen to go out to Borneo, said that only in 1878 there were no less than 160 natives killed on the coast by pirates. Now piracy had quite died out, and, according to the last census, the native population had nearly doubled. Another way in which the population had been increased was by the addition of Chinese. Mr. Walker stated in 1903 that there were 13,000 Chinese in Borneo, whereas last year there were 26,000.

Mr. Cherry Kearton said that within the last three years he had gone round the world with the exception of crossing the Pacific Ocean. He had seen many countries and been in many corners of the earth and many outlandish places. He had been in East Africa, as far as Uganda, and right on the German border. On his second visit to East Africa he had fever very badly and nearly died, and when he came back he heard something about Borneo and decided to make a trip to that country. Before he started, a gentleman in the City told him that Borneo was a fever-stricken place as "all those South American States are." When he went to Borneo, being a naturalist, he was very keen on

photographing the ourang-outang. Growing tired of canoeing in a "dug-out," from which he was frequently pitched out, he took a short cut through the jungle and was sometimes cutting his way through for four or five days at a time. He was out at nights and got very nearly drowned, and although he went through the whole of the central part of the country he never had a touch of fever. When he left Borneo he went to Mysore, and stopped out for seven or eight nights, and then came to England. He thought that, notwithstanding all this, he looked a very good specimen of health. When he was in Borneo he used to go in for gymnastics a great deal. He ran races with British seamen and American seamen on Coronation Day, and he won three races out of four. If a man took care of himself he could get on all right in Borneo. There was a fine opening in that country for any young fellow who liked to go out and work. Work was the keynote. He thought that, if Borneo had as good an advertising agent and Governor as East Africa had, it would be level with British East Africa, for they had got the game there. Scores of people went to East Africa for the game. If Borneo had an experimental farm, which they could easily have up on the mountains, and if the rivers and pools were stocked with the new discovered fish which feeds on the mosquito lava, the river banks would soon repopulate, and they would be able to support plenty of labour. There was also English shipping wanted. He found that he had to go by a German boat from Singapore to Borneo. The same thing happened in British East Africa only two years ago. He could show a photograph of three foreign ships in the harbour of Mombasa and no British ship. When people invested their money and went out to prospect a country like Borneo, the English people ought to help them in every possible way. The men had to work all the time under difficulties, and he had a great admiration for them. They were doing a great and noble work.

Dr. S. G. Kirkby-Gomes said he had been in British Borneo for three and a half years, and while he was there he was associated with the author, who, as district treasurer in North Borneo, found it his duty to collect as much money as he possibly could for the Government, whereas it was the speaker's duty as a district surgeon and a custodian of the health of the people to spend the money, and for these reasons Mr. Lovegrove and himself often had little differences of opinion. When he heard at the beginning of the present session of the Society that a paper on British Borneo was to be read and that the author was to be Mr. Barraut, a former Resident in that country, he told the secretary of the Colonial Section that he thought the Society had been very fortunate in obtaining the promise of a paper. That gentleman was, he believed, about the best authority on British Borneo either in it or out of it. Unfortunately, however, Mr. Barraut was obliged, owing to ill-health, to defer his paper, but it was very gratifying to find that his place had been taken by so able an official as Mr. Lovegrove. The paper gave a very comprehensive view of British Borneo, and he had no doubt that most of those present had obtained a very good and intelligent idea of what the country was. Mr. Kearton had told the meeting that some one spoke to him of British Borneo as being in South America. He (Dr. Kirkby-Gomes) had often heard it spoken of as being a little place in China. It was, as the audience all knew, the second largest island in the world. Mr. Lovegrove in his paper had avoided some dangerous ground. For instance, he did not tell them anything with regard to the health of British North Borneo. He did not tell them that there was a considerable amount of malaria, dysentery, and other diseases there; but Mr. Dent had given them a hint on the subject, and it was well known that Sir West Ridgeway was now in British Borneo making careful inquiries with regard to this matter. He had as his adviser Sir Allan Perry of Ceylon, the able and experienced principal medical officer of that island. The medical department of British North Borneo with which he (the speaker) was connected for several years was now undermanned and underpaid as well. He hoped that Sir Allan Perry's report would be the means of meeting those defects. They would all agree that, whatever revenue was wanted for anything else, the health of the country ought to be maintained.

Mr. Byron Brenan, C.M.G., in moving a hearty vote of thanks to Mr. Lovegrove for his admirable paper, said that the author in a very short paper had taught the audience more about North Borneo than any of them could have learned from all the geographies and histories in their libraries. Both he and Mr. Kearton had made the place exceedingly attractive to them. They had had to suffer the heat and burden of the day, and the audience had been able to listen to an account of their experiences. He hoped that the advice of one of the speakers would be followed, and that many young men would go out and help to develop the country. He spoke feelingly, for he was one of the many persons who had had a little venture in rubber shares, but so far the result had been disastrous. There was much to be learnt from the paper and also from the pictures. He wished that some agricultural labourers had been present to see the pictures, and to observe the zest and energy which the agriculturists of Borneo put into their work. On behalf of the Colonial Section of the Society he wished to express to Earl Brassey most cordial thanks for his great kindness in presiding.

The vote of thanks was seconded by Mr. C. V. Creagh, C.M.G., a former Governor of British North Borneo, and carried.

Earl Brassey acknowledged the compliment, and expressed his personal gratitude to Mr. Lovegrove and Mr. Kearton.

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LIGNO-CONCRETE.*

In the introductory remarks the author refers to the use in America and Australia of concrete in combination with timber, and points out that while the concrete effectively preserves the timber, it is not used to the greatest advantage. The object of the author's investigations was to ascertain if it were possible to reinforce concrete with timber rods. Roughly speaking, steel is about eight or nine times stronger than timber, but ten to fifteen times as expensive. The efficiency of timber, as a reinforcing material, depends on whether there is sufficient adhesion between the timber and the concrete, and whether the difficulties of the absorption of moisture by the timber from the wet concrete, and the splitting the latter, can be overcome.

The paper describes the experiments made by the author to ascertain (*a*) the amount of water absorbed by eighteen kinds of timber immersed in fresh water, along the grain and through the end grain respectively; (*b*) the relative absorption by the timber of fresh and sea water in the same period; (*c*) the relative amount of water absorbed by timber embedded in 6 to 1 concrete and neat cement blocks; (*d*) the effect of applying wood preservative, creosote, varnish, etc., to the timber before insertion in the concrete or cement blocks; (*e*) the effect on the adhesion between the timber and the concrete of soaking the rods before insertion. Examples are given to show that concrete effectively preserves timber embedded in it.

Particulars are given of the construction of twenty-five concrete beams reinforced by timber rods. Three ligno-concrete beams, 8 inches deep by 4 inches wide, were tested with a central load on a 4-foot span; the average ultimate load producing fracture was about three tons. The results of these tests are compared with the tests on ferro-concrete beams recorded by Mr. E. Marburg in the "Proceedings of the American Society for Testing Materials" (1904, Vol. IV.). It appears that for the same ultimate strength of beam, it is necessary to use 9 per cent. of sectional area of pitch-pine tensile reinforcements as against 1 per cent. steel reinforcements. A comparison of the prices of steel and pitch-pine shows a saving in favour of ligno-concrete.

As the author points out, in cases where more than about 1·2 per cent. of steel reinforcement is required, ligno-concrete cannot compete with ferro-concrete, because the required size of the timber bars would be too large for convenient use. There appears, however, to be a big field for it for use in constructing bungalows, buildings for small holdings, floors, piles, posts, fencing, coast and river works, etc. It has already been used for making fence-posts and for building a short length of sea-wall. The ligno-concrete fence-posts cost about two shillings per cube foot. They are about 20 per cent. cheaper than creosoted deal, and about 40 per cent. cheaper than English oak. In Canada four bungalows have been built with ligno-concrete slabs, and the Pacific Coast Construction Company of Victoria, British Columbia, now have contracts in hand for twenty buildings in which this material is to be used.

* Abstract of a paper read by Mr. Gerald O. Case before the Society of Engineers.

THE RUBBER-PLANTING INDUSTRY.

The Imperial Institute has compiled a selection of reports relating chiefly to the composition and quality of the rubber furnished by well-known rubber-producing trees grown in different countries, and under different climatic conditions, and prepared in different ways. On the whole, the cultivation of *Hevea Braziliensis* in the districts suitable for its growth is more profitable than that of any other known rubber tree, and the product holds a great advantage as against the rubber collected from wild vines and other rubber-producing trees, owing to its purity and greater elasticity and strength. In an introduction to the report, Mr. W. R. Dunstan, Director of the Institute, says:—

"The rubber-planting industry is now in a transition stage, and is faced with several problems which will only be satisfactorily solved by systematic research, much of which must necessarily be conducted on the spot. It is a welcome and hopeful feature that this need for investigation is generally recognised, and not only are these problems being attacked by the Government Agricultural Departments in the Tropics, many of which are conducting investigations in conjunction with the Imperial Institute, but many of the larger plantation companies have engaged the services of scientific specialists to conduct investigations into the important problems of tapping, coagulation, curing, and the large subject of the hygiene and pathology of rubber plantations, upon the successful solution of which the future of this great industry depends.

"So long as rubber commanded a very high price, considerable importance attached to those plants which furnished even a relatively small amount of this material, since the profitable separation of the rubber from resins and other foreign substances naturally associated with it in the latex was commercially possible. With a very considerable fall in the price of rubber, and with a greatly enhanced production of first-class rubber, these secondary and inferior sources of the material are less likely to be of importance. A number of such products are alluded to in the reports, some of which also relate to gutta-percha, which is closely allied in some respects to rubber, and was once very extensively employed and purchased at a high price for certain electrical purposes. Now, however, the commercial position of gutta-percha is greatly changed, owing to the fact that rubber itself, in combination with other substances, can be employed for many of those purposes for which gutta-percha was not long ago alone suitable.

"Lastly, reference is made to the investigations conducted at the Imperial Institute into the value

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of the seeds of the Para rubber tree as a source of oil. It is now some years ago since the oil contained in these seeds was first investigated as to its composition and uses at the Imperial Institute. It was shown that the kernel of this seed, which is easily removed from the thin shell, contains nearly half its weight of oil. This oil was found closely to resemble linseed oil in its composition and properties, falling into the class of drying oils, which are used in the manufacture of paints, of linoleum, and of other materials. It was shown that this oil would command about the same value as linseed oil, and that there would be a considerable demand for it as a substitute for linseed oil. With the maturing of large rubber plantations all over the world, the need for seed for planting is rapidly diminishing, and an enormous quantity of seed is becoming available. The present time is favourable for the production of rubber-seed oil, since it now will command a higher price than that originally quoted, owing to the scarcity and consequent greater value of linseed oil."

THE PUBLIC TRUSTEE'S REPORT.

The fourth annual report of the Public Trustee shows that remarkable progress has been made since 1910, when Mr. C. J. Stewart read a paper before the Society on the work of his department. The first Public Trustee was appointed for a period of five years: of these, four and a half have now elapsed. The business transacted during this period is shown by the following figures:—

		Value.
1908 (3 months)	63 cases accepted	£384,317
1908–9 . . .	381 " "	3,133,523
1909–10 . . .	622 " "	4,989,191
1910–11 . . .	877 " "	6,548,641
1911–12 . . .	1,050 " "	8,626,315
	2,993	£23,681,987
Trusts in course of being transferred, 126		£1,000,000
Current business up to March 31st, 1912		£24,681,987
Applications from intending testators requesting that the Public Trustee should act as executor, 2,020 . .		£44,030,000
Total value of the business of all kinds negotiated since January 1st, 1908.		£68,711,987

As this business is growing from day to day, it may be said to be approximating in value to the sum of £70,000,000; 198 estates have been distributed at a value of £2,357,774; 1,166 wills have been deposited for safe custody. The growth of the fees shows an increase as satisfactory as the value of the business itself. The fees were:—1908 (three months), £502; 1908–9, £6,075; 1909–10, £16,640; 1910–11, £24,321; 1911–12, £34,208.

For the past financial year, after taking the £34,000 in fees and spending £29,000 in expenses, there is a surplus left of £5,000. The fees have increased as compared with the previous year by 40 per cent., the expenses incurred in earning these increased fees have increased by 34 per cent., while the surplus of assets over expenditure has increased by 86 per cent.

For the first eighteen months the Department was working at a loss, but the deficit has been obliterated; and for the last three years the Department has shown an increasing surplus—viz., 1909–10, a surplus of £1,521; 1910–11, a surplus of £2,730; 1911–12, a surplus of £5,080. The present financial position is that there is a surplus in cash and also of fees earned (but at the moment uncollected), furniture, and stores, of some £11,000 in value.

NOTES ON BOOKS.

Lectures on Cement. By Bertram Blount, F.I.C. London: The Institute of Chemistry of Great Britain and Ireland. Price to persons not connected with the Institute, 2*s.* 6*d.*

A few months ago the Council of the Institute of Chemistry decided to institute a scheme under which Fellows who have special knowledge and experience in various branches of work, should deliver courses of lectures chiefly for the benefit of young chemists and advanced students, such as those preparing for the final examination for the Associateship of the Institute. The object is to indicate the scope and character of the work actually carried out in various branches of professional practice as distinct from purely academic training. The scheme was inaugurated by this course of lectures, which was delivered before the Institute at King's College, London, on October 26th and December 1st, 1911.

The lectures contain an historical account of the evolution of calcareous cements, including a long and interesting extract from Smeaton's description of the steps he took to obtain a suitable cement for Eddystone Lighthouse. After dealing with chemical reactions and physical changes in the setting and decay of cements, modes of testing, standardisation, the uses of cements, and the causes of failure of cement structures, Mr. Blount devotes some space to what is perhaps the most characteristic feature of this course, viz., the necessary equipment of knowledge and training for an expert, the difference between the conditions of work in a laboratory and in a workshop, and the necessity of learning to think in tons instead of grammes, in steel and fire-brick instead of platinum and porcelain.

There can be no doubt of the practical advantages of such a course to the young cement chemist, nor could the Council of the Institute have found a more suitable lecturer for the purpose than Mr. Blount.

Furniture. By Esther Singleton. New York: Duffield & Co. $7.50 net.

Miss Esther Singleton's book might almost be called an encyclopædia of furniture, for it is

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pre-eminently a volume to be consulted rather than to be read straight through. The authoress is well known in her own country as a writer and also as a collaborator on more than one encyclopædia, and her training and skill in this kind of work have stood her in good stead in the present volume, for she has gone to the best sources, and has used them freely and judiciously. She has, moreover, provided her work with an excellent index, which greatly facilitates its use.

There must be many people who would find this book far better suited to their needs than larger and more cumbrous volumes dealing with furniture and its history, and it is a much more serious work than the majority of comparatively small handbooks on the subject. On the other hand, the work is doubtless better adapted to meet the demands of the American public—to whom, of course, it is primarily addressed—than to appeal to the ordinary British reader. In the first place, a great many of the illustrations are taken from specimens in the Metropolitan Museum at New York, which is obviously the right thing in an American book; but the first thought of the reader on this side of the Atlantic is that he could find more interesting examples nearer home.

Further, the author is concerned mainly with the history of furniture, and this is treated, as many Americans like art-history to be treated, with a name for every minute variation of style, and a good deal of shyness over recognising periods of transition. That is a point of view which is less common in this country, or at least less openly avowed; but once it is granted, Miss Singleton's book must command our respect. It is a conscientious and thorough piece of work, and a large amount of information is compressed into its pages.

GENERAL NOTES.

Musical Instruments at the Victoria and Albert Museum.—Their Majesties the King and Queen have been graciously pleased to deposit on loan at the Victoria and Albert Museum an interesting group of musical instruments. The loan consists of a harmonium, a piano, and a harpsichord. The harmonium, made by Ale. Muller, of Paris, was specially constructed for travelling and can be fitted into a small leather trunk, which is exhibited beside it. This instrument was formerly used on the royal yacht. The piano is an early specimen of the upright grand type, and was made in 1808 by "R. Jones, Upright, Grand and Square Piano-forte maker To His Royal Highness The Prince of Wales, No. 11 Golden Square, London, W." It was therefore presumably constructed specially for George IV. when Prince of Wales. The most important and interesting piece of the three is the harpsichord, which is said to be the original one bequeathed by Handel to King George II. It was made by Hans Ruckers the elder, the first of that celebrated family of Flemish musical instrument makers who worked in Antwerp. It is inscribed "Joannes Rvckers me fecit Antverpiae, 1612," and bears the characteristic "rose" trade-mark representing a seated angel playing a harp between the letters "H.R."

A New Indian Journal.—Messrs. G. A. Vaidya-Raman & Co., of Madras, have just published the first number of the *Wealth of India*, a monthly journal of information and instruction dealing with all topics of material interest. It contains thirty-two pages of reading matter of crown quarto size, and is a digest of facts, figures, and information on all questions relating to industrial, commercial and economic progress. The section entitled "Views and Reviews" contains the cream of the articles on economic questions in periodicals not easily accessible to Indian readers, while the "Notes and Comments" include a variety of subjects including Agriculture, Commerce, Industry, Economics, Co-operation, Banking, Insurance, Scientific and Technical Education, Economic Products, Business Methods, Frauds and Fakes, Machinery and Invention, Industrial and Economic Literature, and Openings for Business.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

April 17. — John Henry Coste, F.I.C., "Municipal Chemistry." Dr. Rudolph Messel will preside.

April 24.—George Fletcher, Assistant Secretary of the Department of Agriculture and Technical Instruction, Ireland, "Technical Education in Ireland."

May 1. — William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

May 8.—E. D. Morel, "British Rule in Nigeria."

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S., will preside.

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

April 25.—Sir John O. Miller, K.C.S.I., "The Central Provinces." The Rt. Hon. Lord MacDonnell, G.C.S.I., K.C.V.O., will preside.

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

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HOWARD LECTURES.

Monday evenings, at 8 o'clock :—

CAPTAIN H. RIALL SANKEY, R.E. (retd.), M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

April 29, May 6, 13, 20.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 15...Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. E. Hatschek, "Colloidal Chemistry and Brewing."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. R. M. Kearns, "The Cost of Labour in Connection with the Erection and Maintenance of Buildings."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. (Graduates' Section.) Mr. F. Burge, "Steam Tractors."

Victoria Institute, 1, Robert-street, Adelphi, W.C. 4.30 p.m. Rev. Professor G. Henslow, "Directivity of Life, as seen in the Structure of Plants and Animals."

Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. L. Weaver, "Some Scottish Houses of the Renaissance."

TUESDAY, APRIL 16...Illuminating Engineers, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. H. W. Y. Webber and Mr. W. R. Rawlings, "The Lighting of Private Houses by Gas and by Electricity."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. E. T. Richmond, "The Significance of Cairo."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. Gosse, "Algernon Charles Swinburne: his Early Life and Work." (Lecture I.)

Civil Engineers, 25, Great George-street, S.W., 8 p.m. 1. Hon. Sir Francis J. E. Spring, "The Remodelling and Equipment of Madras Harbour." 2. Mr. H. H. G. Mitchell, "The Alteration in the Form of Madras Harbour."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. Alfred Watkins, "New Methods of Speed and Gamma Testing."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8 30 p.m. Mr. E. T. Powell, "The Faith of an Imperialist."

WEDNESDAY, APRIL 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. H. Coste, "Municipal Chemistry."

Meteorological, 25, Great George-street, S.W., 7.30 p.m. 1. Messrs. J. E. Clark and R. H. Hooker, "Report on the Phenological Observations for 1911." 2. Messrs. R. G. K. Lempfert and W. Braby, "A Method of Summarising Anemograms."

Geological, Burlington House, W., 8 p.m. 1. Mr. H. H. Thomas and Professor O. T. Jones, "The Pre-Cambrian and Cambrian Rocks of Brawdy, Hayscastle, and Brimaston (Pembrokeshire)." 2. Professor O. T. Jones, "The Geological Structure of Central Wales and the Adjoining Region."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Mr. J. D. Siddall, "Note on the Life-history of a Marine Diatom from Bournemouth." 2. Mr. E. B. Stringer, "On a Modified Form of the Lever Fine-adjustment and a Simple Turn-out Device for the Substage Condenser."

United Service Institution, Whitehall, S.W., 3 p.m. Brigadier-General H. De B. De Lisle, "The Strategical Action of Cavalry."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Lecture by Professor W. L. Courtney.

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. 1. Dr. Talfourd Ely, "Excavations near West Marden and in Hayling Island." 2. Dr. Philip Nelson, "The Fifteenth-Century Painted Glass in the Church of St. Michael, Ashton-under-Lyne, depicting Events in the Life of St. Helena."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. E. Kilburn Scott, "The Lay-out and Erection of Electric Power Plant."

THURSDAY, APRIL 18...China Society, Caxton Hall, Westminster, S.W., 8.30 p.m. Mr. L. Giles, "The Great Chinese Encyclopædia."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Dr. D. H. Scott, "On *Botrychioxylon paradoxum*, a Palæozoic Fern with secondary wood." 2. Dr. E. A. Newell Arber, "On *Psygmophyllum majus*, sp. nova, from the Lower Carboniferous Rocks of Newfoundland, together with a Revision of the Genus, and Remarks on its Affinities." 3. Mrs. Henshaw, "The Alpine Flora of the Canadian Rocky Mountains."

Chemical, Burlington House, W., 8.30 p.m. 1. Mr. E. Hope, "The Condensation of Ethyl Sodiomalonate with Ethyl Citraconate and the Synthesis of β-Methyl Tricarballylic Acid." 2. Mr. J. J. Sudborough, "The Formation and Hydrolysis of Esters of Ketonic Acids." 3. Mr. L. A. Levy, "Studies on Platinocyanides." 4. Dr. A. G. Perkin, "Purpurogallin." (Part II.) 5. Messrs. H. Davies, H. Stephen, and C. Weizmann, "$\alpha\alpha^1$-Derivatives of Adipic and β-Methyl Adipic Acids. Preliminary Note." 6. Mr. S. Ruhemann, "Methylenedioxy-triketohydrindene." 7. Mr. P. May, "Aromatic Antimony Compounds. Part IV.—Compounds of Antimony Trichloride with Diazonium Chlorides." 8. Messrs. F. Tutin and H. W. B. Clewer, "Note on the Constituents of Rhubarb." 9. Mr. R. Wright, "Molecular Weight Determinations from the Relative Lowering of the Vapour Pressure of Ethereal Solutions." 10. Mr. H. D. Law, "Electrolytic Reduction. Part VI.—Unsaturated Aldehydes and Ketones." 11. Mr. J. E. Myers, "A Method of Estimating Potassium Iodate."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. W. Crossley, "Synthetic Ammonia and Nitric Acid from the Atmosphere." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. Haldane Macfall, "Has Modern Painting any Lessons for the Artist-Photographer?"

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Discussion on "The Causes Preventing the more General Use of Electricity for Domestic Purposes."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. Louis Felberman, "St. Margaret of Scotland."

Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m.

FRIDAY, APRIL 19...Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. O. Campbell Swinton, "Electricity Supply, Past, Present and Future."

Medical Officers of Health, 1, Upper Montague-street, W.C., 5 p.m. Dr. J. A. Gibson, "The Housing (Inspection of Districts) Regulations, 1910."

Brewing, Institute of (Yorkshire and North-Eastern Section), Queen's Hotel, Leeds, 8 p.m. Mr. Percy Russell, "Fine Grinding of Malt."

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Dr. Walter Rosenhain and Mr. S. L. Archbutt, "Tenth Report to the Alloys Research Committee: On the Alloys of Aluminium and Zinc. With a Short Appendix on a Ternary Alloy of Aluminium with Zinc and Copper."

SATURDAY, APRIL 20...Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Blomfield, "The Architecture of the Renaissance in France. Lecture I.—1494–1547. The Amateur."

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Journal of the Royal Society of Arts.

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FRIDAY, APRIL 19, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, APRIL 24th, 8 p.m. (Ordinary Meeting.) GEORGE FLETCHER, Assistant Secretary of the Department of Agriculture and Technical Education, Ireland, "Technical Education in Ireland." R. BLAIR, M.A., B.Sc., Education Officer of the London County Council, will preside.

THURSDAY, APRIL 25th, 4.30 p.m. (Indian Section.) SIR JOHN O. MILLER, K.C.S.I., "The Central Provinces." THE RIGHT HON. LORD MACDONNELL, G.C.S.I., K.C.V.O., will preside.

Further details of the Society's meetings will be found at the end of this number.

CONVERSAZIONE.

The Council have decided that the Society's Conversazione shall in future be held biennially instead of annually, and that no Conversazione shall be held this year.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 17th, 1912; RUDOLPH MESSEL, Ph.D., F.C.S., President of the Society of Chemical Industry, in the chair.

The following candidates were proposed for election as members of the Society:—

Archer, Captain F., Main-road, Akyab, Burma.

Astley, Rev. Hugh John Dukinfield, M.A., Litt.D., The Vicarage, East Rudham, Norfolk.

Barnes, Charles A. Albert, Assoc.M.Inst.C.E., Government Survey Schools, Lagos, West Africa.

Eades, C. T., Beech-grove, Cheshom Bois, Bucks.

Jasonidy, Omphrius John's, Blondel-street and Empress Ireni-street, Limassol, Cyprus.

Jones, Bassett, Jun., 1, Madison-avenue, New York City, U.S.A.

Laut, Miss Agnes C., Wassaic, Duchess County, New York, U.S.A.

Line, Charles Arthur, 39, Beaufort-road, Edgbaston, Birmingham.

Mackinney, Valentine Henry, Deancot, 85, Woodstock-avenue, Golder's Green, N.W.

O'Connor, H. J. Courtenay, Limehayes, Killyon-road, Larkhall-rise, S.W., and Bathurst, Gambia, West Africa.

Robins, Herbert George, c/o Tanganyika Concessions, Ltd., Lulua Poste, via Elizabethville, Katanga, Belgian Congo.

Skrimshire, Alfred J., 31, Ryde Vale-road, Balham, S.W.

Weir, Charles James, Moorcroft, Silvermere, Cobham.

The following candidates were balloted for and duly elected members of the Society:—

Beecroft, D, The Class Journal Co., 231-241, West 39th-street, New York City, U.S.A.

During, Claudius Dyonisius Hotobah, 15, Pulteney-street, Freetown, Sierra Leone, West Africa.

Hartley, Frank Reginald, 3, Esplanade-road, Scarborough, Yorks.

Jenner, Harry, 35, Auckland-road, Ilford, Essex.

Markel, Karl Emil, Ph.D., 20, Queen's Gate-terrace, S.W.

Stockdale, William, Rosebank House, Stubbins, near Manchester.

Sutherland, William George, The Birches, Ashton-on-Mersey.

The paper read was—

MUNICIPAL CHEMISTRY.

By J. H. COSTE, F.I.C.

Although the passing of the Local Government Act, 1888, marked a definite epoch in the evolution of local government and led to a broader conception of the duties of municipal corporations, it must not be forgotten that great progress had been made in the internal public service of this country before that time.

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This Act was rather the result of the feeling that

"Of good things none are good enough,"

and possibly that

"Of old things all are over old,"

than that nothing then existing was good in local administration. That it gave a great stimulus to municipal life is undoubted, and it is certain that the people of to-day would not be satisfied with the public services which sufficed their grandfathers.

The complexity of the duties of municipalities, even of the smaller ones, has led to the need of a class of officers who formerly were only required by the greater bodies and whose duties are advisory rather than administrative. When the duties partake of the latter character they are of a kind which were not utilised or, indeed, available until the nineteenth century had run great part of its course. Such officers are the medical officers of health, a relatively new type of medical man, engineers, architects, and, more particularly, analytical and consulting chemists.

I propose to indicate briefly the various classes of services which are rendered by chemists to local authorities, and, further, to consider the special qualifications and experience which are required of such chemists.

I.

(i.) The first class comprises those duties which are imposed by Act of Parliament, and which necessitate or imply the creation of certain statutory appointments. The officers appointed have specific duties often in themselves of a routine character, but which only attain to their full utility when carried out by a chemist of some experience.

(1) The oldest group of Acts under which *ad hoc* appointments of this kind are made are those regulating the great gas industry. The Metropolitan Gas Act, 1860, Section 27, provided, as a condition of districting of the thirteen companies then in the Metropolis (which now, by successive amalgamations are reduced to three), and the consequent creation of monopolies, that the gas supplied by them should be tested to ascertain that a prescribed standard of quality was maintained, and that "Every local authority taking any supply of gas according to this Act . . . shall appoint . . . a Chemical Examiner or Gas Engineer or other Competent Person to be an Examiner for the Purposes of this Act." The various Acts relating to the Metropolis and to the provinces, more particularly in the latter case the Gas-works Clauses Act, 1871, have provided that testings shall or may be made. It will be noted that, although great latitude is allowed in the qualifications of the persons to be appointed, a chemical examiner is mentioned first, and the only actual requirement is competency—and, in later Acts, the very obvious one of impartiality. The greater part of the work, the determination of illuminating power, and, in some places, the much more important calorific power, is physical rather than chemical; but it has long been associated with the chemist, partly perhaps because it is recognised that gas-making is essentially a chemical industry and that the physical properties of gas are determined principally by its chemical composition. Although the work is in itself of a routine character, and the methods are rigidly prescribed, it is obvious that a knowledge of the principles underlying them is to be desired in all cases, and, when an examiner is also adviser on gas matters to his authority, an intelligent and in some respects a sympathetic knowledge of the modern conditions of gas-making is necessary, in order that the advice tendered may both safeguard the public interest and allow the legitimate and economical expansion of a great industry on which has been conferred the important duty of utilising to the best advantage a large proportion of our limited supply of fuel.

(2) Another group of Acts, the earliest of which (1871) is now of respectable antiquity, relates to the sale and storage of petroleum, matters seriously affecting the public safety. The officer mentioned in the Acts appears to be rather a sampler than a chemist or tester, but nevertheless it has been held to be safer to appoint a testing officer. Although in many places the chief constable or inspector of nuisances does this work, the modern uses of petroleum products and of materials equally inflammable with petroleum, but not coming within the purview of the Acts, render the possession of considerable chemical knowledge a *sine qua non* for the proper conduct of such examinations. More especially is this the case since a legal decision and a subsequent Order in Council have confirmed the view held by one testing authority that the Acts applied to *mixtures* containing petroleum. A consideration of the dangerous properties of some petroleum products, and of the more or less allied bodies which the law includes under the general name of petroleum, will point to the desirability that these Acts should be vigorously but, in view of the great and rapidly-growing uses of petroleum, judiciously administered.

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(3) The quality of the food of a nation, more particularly that of its children, is a matter of the utmost importance, and, unfortunately, the temptation to tamper with it is apparently very great. If gross adulteration is now but little practised there are, nevertheless, many cases in which the public, if not actually poisoned or starved, is cheated by being given articles which are "not of the nature, substance and quality demanded." The Food and Drugs Act, 1872 (Section 5), gave power to the local authorities of a district to "appoint...one or more persons possessing competent chemical and microscopical knowledge as analysts of all articles of food, drink and drugs purchased within the district." Since this Act several others have been passed with a view to securing a better control over the quality of foods and drugs. It cannot be said that the Acts are on the whole administered in the best manner, or that they are such as to safeguard the public to the fullest extent. Moreover, there is no doubt that considerable chemical and legal knowledge is at times made use of by those who desire to evade the law. Much of the adulteration of food as now practised is of a very subtle kind, and only to be detected with difficulty, and the public analyst has not the same advantage as the author of the modern detective novel—his part is only to detect adulteration analytically; he has no opportunity of being present at the synthesis of the sophisticated food or drug. On the other hand, it must be remembered that the use of new food products under names which are not misleading may be a legitimate outcome of a wider knowledge of the properties of materials.

The public analyst to-day must, if he is to do his work well, be possessed of chemical and microscopical attainments of a high order. A wider field for investigation is open to the man who would place the examination of many familiar foods in a position of unassailable certainty by means of processes based on sound premises, and not so tedious as to be beyond the scope of an ordinary, and, I may add, not very highly remunerated analytical practice.

A summary of these appointments shows how they are distributed in the United Kingdom:—

SUMMARY OF PUBLIC ANALYST APPOINTMENTS.

	Number of Appointments.	Number of Analysts.
England and Wales . . .	232	104
Scotland	238	17
Ireland	45	7
	515	128

NUMBER OF APPOINTMENTS.

England and Wales.

61 Administrative Counties.
29 Metropolitan Boroughs (including the City of London).
144 other Boroughs.
234

Scotland.	*Ireland.*
33 Counties.	33 Counties.
205 Burghs.	13 Boroughs.
238	46

Details of the samples examined from 1901 to 1910 are taken from the reports of the Local Government Board:—

	Total Number of Samples.	Milk.	Butter.	Drugs.	Head of Population.	Percentage reported against.
1901 . .	67,841	26,143	11,938	2,301	471	8·8
1902 . .	72,321	29,452	13,387	2,353	450	8·7
1903 . .	78,077	33,090	13,766	2,718	417	7·9
1904 . .	84,678	34,413	15,124	3,244	384	8·5
1905 . .	86,182	39,341	16,287	3,232	377	8·2
1906 . .	90,504	42,335	16,991	2,726	359	9·3
1907 . .	93,716	44,364	18,176	4,024	347	8·1
1908 . .	95,664	45,093	20,729	3,289	340	8·5
1909 . .	98,544	46,678	21,134	3,347	330	7·5
1910 . .	100,749	47,895	20,742	3,084	323	8·2

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The percentage of adulteration from the same source in quinquennia :—

1877–1881.	1882–1886.	1887–1891.
16·2	13·9	11·7
1892–1896.	**1897–1901.**	**1902–1906.**
10·6	9·0	8·5

It will be seen that the number of samples examined is slowly increasing, and that the percentage of adulteration detected is decreasing.

(4) An Act closely connected with those regulating the food of man is that which empowers the authorities of counties and county boroughs to control the sales of food for the lower animals, and for plants, viz., the Fertilisers and Feeding Stuffs Act, 1906, which replaces one passed in 1893. This Act, although in its details far from an ideal measure, has, without doubt, very greatly reduced the gross fraud which at one time was practised on the agricultural and, through them, on the general population. Although it would appear at first to be a measure of rural rather than urban importance, it must be remembered that a great many sales of the materials take place in towns.

The official agricultural analysts appointed under this Act must not only be capable of performing analyses by the methods which are prescribed for them by the Board of Agriculture and Fisheries, but should have a good microscopical knowledge of the various grains and seeds used for the preparation of cattle and poultry foods and of their adulterants. In addition, a real knowledge of the feeding or toxic properties of substances is necessary in order to enable analysts to certify whether foods contain worthless or deleterious ingredients. A case which recently attracted some attention in Parliament, as well as in a court of law, will illustrate this class of problem. The question at issue was as to whether hydrolysed sawdust should be considered as worthless or not. Great diversity of opinion was expressed.

There is no doubt a growing tendency on the part of public bodies which confer their statutory appointments, of the kind indicated above, on private practitioners, to consult them on the administration of the statutes and on new legislation, but it is not always realised that the advice given can, like legal or medical advice, be recognised in a tangible, even if not altogether adequate manner, by a suitable honorarium. Of course, public bodies appointing whole-time officers at reasonable salaries have a right to the best professional services of these officers, but the private analyst holding public appointments is not always well treated.

(ii.) Some of the statutory duties of public bodies can only be carried out continuously in an efficient manner when the services of a chemist are available, since the operations involved are either directly connected with chemical change or the materials concerned are such as can be most suitably examined by chemical means.

If it were possible rapidly to convey sewage from a district without considering its effect on the locality to which it was taken, sewage disposal would be purely, as it is largely, an engineering question. Since it is necessary to effect great changes in its chemical nature before it can be allowed to escape beyond control and ultimately perhaps to mingle with the water-supply, the problem is obviously one in the solution of which the chemist should take a part. Local circumstances will tend to indicate whether a system of chemical* or bacterial treatment shall be adopted. In the latter case, the purification effected naturally by bacteria and other organisms is so accelerated by a more or less artificial encouragement of their growth that it suffices for practical treatment of sewage on the large scale. The need for the chemist does not cease with the inception and successful starting of a scheme any more than that for the medical man does when he has safely introduced an infant to its sphere of future activity. Sewage purification cannot be relied upon to be entirely automatic, but the quality of the raw sewage and of the final effluent must be watched by means of chemical analysis, and possibly, from time to time, suitable modifications of the original scheme must be devised to meet the special difficulties which may arise.

The regulation of offensive trades and other matters affecting the public health, and the administration of other services of control, frequently call for the aid of the chemical expert as a consultant or as an analyst.

(iii.) In many matters normally connected with the executive work of local government, the services of a chemist, although perhaps not obviously needful, are required if the highest efficiency consistent with economy is to be reached. For example, the various residential institutions, educational, curative, preventive or protective, are frequently extra-mural, and in such cases are more or less self-contained with their own sewage works, gas or electricity works, and water-supply. In any case, large quantities

* That is, treatment *with* chemicals. Bacterial treatment is, in a true sense, chemical.

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of foods, cleansing materials, textile goods, oils, paints and other engineers' stores and fuel, are purchased annually, probably at very low contract prices. Systematic chemical examination of these materials is in many cases the best, sometimes the only means of securing that the goods supplied are of the required quality and at the same time allowing freedom of contract. The careful framing of specifications for goods, not necessarily the best obtainable, but of useful quality, and such as can be economically produced in the ordinary course of industry, is a matter which calls for the best abilities of the chemist. It is advantageous for a control exercised independently of the officers actually using the goods—although, of course, by no means antagonistic to them—to be available. Of this I will speak later.

(iv.) The growth of municipal enterprise, particularly in such directions as the supply of water, light, power, and the provision of means of locomotion, has increased greatly during the last decade. The question of the relative advantages of municipal and private undertakings is not one on which views are unanimous, but it will be agreed that when such services are undertaken by public bodies, the highest efficiency—including economy of administration—should be sought. Such efficiency is in many cases promoted by the aid of a chemical examination of the materials used in the necessary works, by advice as to the best materials for special purposes, and on the cause of failure of materials. In the case of supplies of water or gas, a systematic examination of the products supplied by, as well as to, the undertaking is required. Few who are not engaged in such work will realise the great variety of goods used, in many cases without any adequate guarantee of quality. Many problems, involving much more than mere routine examination, and not always easy of solution, frequently arise.

It may be asked, in fact it is frequently asked, is not the proof of the pudding in the eating, and can the fitness of materials required for a great variety of purposes be determined by a person who handles them on an almost microscopical scale, and who, in many cases, is altogether incapable of using them practically? I think we all have seen many puddings which we would willingly prove in any possible way before taking the risk of eating them, and we are all aware that inferior and defective articles of every kind are offered for use and are used with most unfortunate results. "It follows," therefore, "that in questions of difficulty, or such as are thought so, where more satisfactory evidence cannot be had or is not seen: if the result of examination be, that there appears upon the whole, any the lowest presumption on one side and none on the other, or greater presumption on one side, though in the lowest degree greater, this determines the question, even in matters of speculation; *and in matters of practice, will lay us under an absolute and formal obligation, in point of prudence and of interest to act upon that presumption of low probability*, though it be so low as to leave the mind in very great doubt which is the truth."*

This quotation from an eighteenth-century writer fairly illustrates the very weakest ground on which the report of an expert of any kind rests, a sufficient ground to decide any action when all other determining factors are equally balanced.

I think that the function of the consulting chemist, as distinguished from a mere analyst, is so to approximate his methods of testing substances used in arts, manufactures and commerce to the conditions of their use, and to base his interpretations of analyses, or other examinations, on sound *a priori* grounds or on the results of assured experience that his reports on the relatively rapid examination of small quantities may, with the highest degree of probability, anticipate the behaviour of such substances when actually used on the large scale. This is by no means always easy, and, at times, the probability is not much higher than is supposed in the above quotation. But, since in all things probability is the guide of life, it may be claimed that the report of the consulting chemist is frequently the best, most impartial, and least costly determining factor.

In addition to all the more or less constant and regular demands for chemical assistance to the modern municipality, public bodies at times when engaged in litigation, or in promoting or opposing legislation, seek advice and require evidence to be given on their behalf on questions of chemistry as applied to industry or other matters of general importance. How is advice and assistance of the various kinds indicated to be obtained?

II.

That public bodies should in any branch of their service secure the best man available none will deny. How to obtain such a man is a less easy matter to decide.

In chemical, as in all other public services, the question of the whole-time officer *versus* the

* Introduction to Butler's "Analogy."

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outside expert must be considered. The late President of the Society of Public Analysts, speaking more particularly of this class of officers, said in his retiring address:—"The system of county authorities appointing a 'whole-time' officer for carrying out the work required by them is one which . . . has 'come to stay,' and it cannot be denied that there is a good deal to be said in its favour if carried out on proper lines. But the establishment of a municipal or county laboratory at the expense of the ratepayer on the lines of a municipal trading concern is highly objectionable." This quotation expresses very fairly the feeling of the best class of private practitioners. I think both systems have their advantages, and while this remains so we shall see both systems side by side. It is the man who is merely an analyst who will feel most hardly the growth of the "whole-time" system. The man in practice who is really an expert on any subject of public utility, will find that his special knowledge enables him to hold his own as a private practitioner.

How are we to find a man with the desired qualifications?

It was realised in 1885 "That the profession of analytical and consulting chemistry is one of great importance to the public, and, having regard to the rapidly-increasing application of chemistry to legal investigations, to public health, to the adulteration of food, to agriculture, and to the arts and manufactures, it is desirable, that persons practising the profession of analytical and consulting chemistry should have both a practical and scientific knowledge thereof.

"That it is a matter of increasing importance to Government Departments, corporate bodies, and others requiring the assistance of persons competent to practise in analytical chemistry and to advise in technological chemistry, that such persons should be properly trained and that their qualifications should be attested by certificates of competency granted by a scientific body possessing sufficient status," and that at the time there was no such body in existence.

The result of this feeling was that a charter, the preamble of which I have just quoted, was granted to the Institute of Chemistry, a body which had been founded some eight years earlier. This is the only body which grants a certificate which can be considered as attesting the required qualifications, and it is recognised as such by most of the various appointing or confirming authorities. It obviously cannot confer on, or to more than a limited extent require of, its members, experience, which can only be acquired slowly and painfully. It is, however, a great deal for it to attest real competency, even if not always of a mature kind.

The municipal chemist must be able to take a sympathetic interest in chemical industry and to give practical advice to his authority when it comes in contact with industry. He must look on industry as a thing to be encouraged as well as controlled. A member of the Society of which our Chairman is President, has no excuse for being ignorant of industry, even although he himself may have no direct connection with it.

The municipal chemist, more especially the "whole-time" man in a relatively comfortable appointment, must read, think and experiment, and should feel that his education—ever progressing—had hardly started when he finished his formal scholastic course, that then he had certainly learnt the names of his tools, and had some idea of their uses, but that he must continually strive to become more expert with them. It is, I need hardly say, an unfortunate thing for the municipality, the man, and the profession, if a raw fledgling obtains an independent appointment. It is difficult for such a man to magnify his office. Fortunately the contingency is of rare occurrence.

It is not always possible or desirable for one man to perform the whole chemical work of a municipality, and, on the other hand, some bodies have not enough work to occupy the time of one official or could not sufficiently remunerate a man of experience adequate even for their normal requirements. Here the natural division between the fields of action proper to the departmental and the external systems is indicated.

Large public bodies, having a great variety of duties and undertakings, in most cases have adopted the departmental system. A good all-round man, possessing special knowledge, with a graded series of subordinate officers, will be able to conduct all the work normally arising, and he will probably feel able to take a holiday without suffering much uneasiness. The need for economy of effort will tend to some specialisation on the part of subordinates, some of whom, in consequence, may develop into mere but useful routine workers highly skilled in certain classes of work. The more enterprising and mentally industrious will develop real specialist knowledge. Every good chemical department is an educational establishment, and its records form a dictionary of applied chemistry which is continually being re-edited and brought up to

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date. The external expert will from time to time need to be consulted, and the ripe knowledge of the head of the department will indicate who should be consulted—a most useful service, since obviously a man's willingness to give advice is no certain measure of his knowledge. Smaller bodies do the same thing as the larger, but on a less ambitious scale; but still the chief can take a holiday with safety. He will, however, be likely more frequently to need the co-operation of the outside expert than the man in the larger town.

Unless a public body can afford to pay a good man with a fairly good man under him, it will probably do wisely to appoint a private practitioner as public analyst, preferably one with a laboratory in the district—but this cannot in reason always be—and to arrange with him to undertake its general analytical work, to advise them or to put them in touch with more specialised knowledge than his own. It is clearly to the advantage of an authority with but little work requiring chemical aid to make use of the abilities and knowledge of a private practitioner, who can in this way give them the fruit of a much more varied experience than they could otherwise command.

The training of chemists up to the stage of B.Sc., or the Intermediate examination of the Institute of Chemistry, is properly a matter for the colleges to look to. I think these institutions should keep in view their proper functions in regard to the training of the consulting and analytical chemist. If they turn out men well-grounded in the *principles* of the science of analytical chemistry and the *methods* of chemical analysis, and generally well educated, having a fair knowledge of mathematics and physics, who can think clearly and express their meaning in their own language, they have done a great work; accurate observation, exact and directed experiment and clear thought form the basis of all scientific progress. The *application* of the principles and methods of analysis is best studied in a laboratory where it is one of the serious businesses of life, and where the problems to be solved are real ones to which an answer is imperatively demanded. Immature specialisation is thus avoided. It is a hopeful sign that evening advanced courses on special subjects of applied chemistry are being given, at least in the Metropolis, by men who are working daily at such subjects.

I have tried to indicate the advantages to the public service of chemical assistance. In doing so, I have endeavoured to face continually the fact that the general public is not yet enthusiastically convinced of the need for such assistance, and that they will be persuaded to this conviction only by evidence of the utility and even the necessity of the chemist's services in conserving the resources of this very limited planet.

DISCUSSION.

THE CHAIRMAN (Dr. Rudolph Messel), in opening the discussion, said that the work done in municipal laboratories required the highest skill of the scientific man. For instance, in regard to gas, he had to make tests not only with regard to its chemical qualities, but its calorific power, and he had to carry out similar duties in relation to petroleum and such-like materials. With reference to the Food and Drugs Act, it was most satisfactory to notice, that, notwithstanding the increased number of samples taken, the percentage of adulterated material was less. It was astounding that so small a staff should be considered sufficient to do all the work that was now demanded from analysts, especially considering how particular the people of the country were with regard to their food products. The author had also referred to the work done under the Fertilisers Act, which had undoubtedly been a means of great good. In his concluding remarks Mr. Coste had mentioned the lack of enthusiasm shown by the general public on the subject, but that, perhaps, was not surprising when sewers were concerned. The author had inquired who was the best man to undertake the various classes of work referred to in the paper. Personally, he thought it was essential to have a man who had a thorough scientific education to begin with, and that he should then gain such experience in life as was necessary in every kind of industry. Not only was a thoroughly competent man required inside the department, but it was also advisable to seek outside advice from people who had experience of a much wider field of operations.

COLONEL CHARLES E. CASSAL said he was pleased to find the paper contained a number of expressions of pious hope, which he trusted would meet with realisation in the future. The author very properly desired the public to understand that a man who held the position of a municipal chemist should not only be a highly-trained man, but must possess such personal characteristics as would enable him to be looked upon as absolutely reliable. He agreed with the author that it was not always easy to find an Admirable Crichton capable of filling a post of that kind with credit to himself and advantage to the public. Part of the difficulty lay in the fact that the English system of scientific education was only of yesterday; that it required great development and great improvement; and especially in chemistry it was by no means as yet clear to those who were the leaders on the question of chemical education which

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was the best course to take to train a man to fit him for the particular kinds of work to which reference had been made. Another extremely interesting point was the question of the treatment of those Admirable Crichtons when they were found. He did not hesitate to say that the usual treatment accorded by most public authorities to such professional officers was abominably bad; it was, in point of fact, in most cases disgraceful. There was a greater tendency nowadays to "skin" the professional man than there had been in the past, and that tendency seemed to be increasing considerably. The municipalities of this country did not yet understand any more than the public at large understood that it was essential, if they wanted good work and sound advice, that they must employ a good man and pay him adequately, as every other decent professional man was paid. His experience lay more in the direction of public analytical work, and he did not hesitate to say that the general treatment of public analysts was a disgrace to the country. Two examples had recently occurred of the sort of thing which certain municipal bodies did when they appointed an officer of that kind. The Borough Councils of Wandsworth and Lambeth recently advertised that the appointments of public analysts for their districts were vacant, and had placed the rate of remuneration for those officers at absolutely the lowest point that had ever been suggested. How was it to be expected that self-respecting men, to say nothing of qualified men, would accept posts of such importance upon terms of that kind? The Council of the Institute of Chemistry very properly called upon its Fellows and Associates, if they had offered themselves as candidates for those posts, to withdraw their applications, and he was pleased to say that, with two exceptions, all the candidates did so, leaving the two local authorities with a couple of candidates apiece. Such things ought not to be, and the central authority which was concerned with the matter should prevent them. It ought to be the duty of the central authority to see that the proper man for the post was adequately paid, and to refuse, as they had the power to refuse, to sanction appointments made upon such bases. One point upon which the author had not touched was that if his desires were ever to be realised; if county councils and the municipal authorities of London were to be properly served, one of the first things that must be done was that the central authority controlling all the local bodies should insist that the right man was appointed; that he had certain specified qualifications; and that he should be paid at such rates that he was not compelled by necessity to do bad work. With regard to the question of the Food and Drugs Acts, this country was behind every civilised country in the world in their administration. In a paper he had the honour of reading in that room not very long ago, he pointed out that, compared even with some of the younger colonies, the United States, France, and Germany, Great Britain was a long way behind the proper administrative position that it ought to hold as the country which first initiated laws directed against adulteration. It was ridiculous that the present system should continue to exist. The central authorities were concerned apparently with the general administration of the Food and Drugs Acts, the Fertilisers and Feeding Stuffs Act, and various other Acts, but the officers of the central authorities apparently had not power to insist upon adequate and effective administration of those Acts. Recently a large vinegar brewing association applied to the Local Government Board with regard to the question of the adulteration of vinegar, and that Government department replied that they had no power to deal with the matter; and they confined themselves to the expression of the opinion that vinegar ought to be so and so, that malt vinegar ought to be so and so, and that the standard of acetic acid should be so and so. But that was of no use to a public authority. It was of no use for their officials to go into court and prosecute on a mere expression of opinion or of the hope of a Government Department. It was necessary that some definite regulations should be laid down which had the force of law, and without that it was perfectly useless to disseminate a mere expression of pious hopes and opinions. His remarks applied not only to that particular question but to the Fertilisers and Feeding Stuffs Act, which was a dead letter. It was so hedged about with complications and with the necessity for applying to the central authority to move one's little finger, that it was absolutely useless as a Preventive Act throughout the country. In order that the author's desires might be carried some day into effect, he would like to see, in the first place, some competent central court or authority established, composed of experts who understood the different subjects which had to be dealt with, which could act as a sort of directing court of reference in regard to all matters of that kind. Instead of having to fight a variety of complicated questions in courts of law, before an ignorant magistrate with ignorant counsel, the law ought to be laid down in such a way that there could be no question as to what should be done. He trusted that the officers the author desired to see would some day be appointed, and especially that they should be of the type he referred to, and above all that they should receive emoluments worthy of their office, and not the sort of payment which was doled out to a second-rate sanitary inspector or a broken-down police constable. Whatever might be arrived at in the future, the present condition of things in regard to municipal chemistry was abominably bad from one end of the country to the other, and required thorough reform.

Mr. Walter F. Reid thought the paper clearly illustrated that it was requisite for the municipal chemist to know a very great number of things besides chemistry. It was absolutely essential that he should have a knowledge of the laws bearing

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on the subject, but that was unfortunately a part of the education of the chemist which was generally neglected. When he came from his training college he had to make himself acquainted with a large amount of legislation of which he had been previously ignorant. He agreed with the author that it was futile to place a novice, or one who had just passed a very brilliant chemical examination, in an official position where he was one of the most important administrators of Acts of Parliament. Colonel Cassal seemed to think that the position of this country with regard to adulteration was inferior to the position in foreign countries. Personally he was not quite sure whether the public in this country would put up with the position as it existed in some foreign countries. For instance, he was quite sure there would be an outcry amongst some very great industries if the Bavarian law with regard to the adulteration of beer were to be introduced. If a manufacturer put into his beer articles that were used in the vast majority of breweries in this country, he would forthwith be haled off to prison. He remembered some years ago, when some English chemists were over in Paris they were received in the first instance by the President of the Paris Municipal Council, and in the second place by the Prefect of Police. Some of the English chemists could not quite understand why they were welcomed by the Prefect of Police, but he justified his position most clearly when he said that the bulk of the convictions obtained in Paris for infractions of the law were only rendered possible by the services of the chemists. That was a view that the public authorities in this country hardly took up; they did not attribute to the chemist the importance that really attached to his office. If the cases in the criminal court were carefully followed it would be found that year after year the convictions in perhaps the majority of cases were obtained owing to the assistance rendered by a chemist. For instance, to mention one of the most recent murder trials, the Seddon case, where would the authorities have been without the assistance of a very expert chemist, who must have had a very long training to do the work he did? With regard to the question of pure food, he thought this country was not in a very backward position, but the position it occupied, and the great advance which had been made, was due to the care and supervision exercised by the public analysts. Unless the duties were carried out with the greatest conscientiousness, the examination of samples would be perfunctorily undertaken, but he had rarely heard of a case where an instance of adulteration had escaped the detection of the analyst, and that was the more wonderful because, from the very nature of the case, the public analyst had very little opportunity of coming into contact with the industries the products of which he had to examine. One passage in the paper which had struck him very much was the statement that evening classes were held, especially in large towns, by those who were in actual practice in different industries. That kind of tuition was, he thought, of the very greatest importance to those who were carrying out public functions as chemists, because unless one was actually in contact with the industries it was impossible to keep up to date and find out what the tricks were which might be played upon the public. It had been said that wherever a chemist found out adulteration there was always some other chemist ready to mask it or disguise it. That, undoubtedly, was the case. People would always be found who would prostitute the science they possessed to deceiving their fellow beings, and that could only be met by increased skill and ability on the part of those who had to produce articles. The point he emphasised was that there should be some contact between those who were testing the products and those who were making them in some way. Public analysts were always to the fore whenever any opportunity was given them to visit factories and gain technical information. The author had not touched upon the question of the application of chemical knowledge to the materials which were used in large cities in order to prevent the mis-applied efforts that were now made in so many cases. An exhibition in connection with smoke abatement had recently been held, and some excellent papers had been read on the effect of the atmosphere on building materials. There was a great want of supervision in London with regard to the materials used. Hundreds and thousands of pounds had been subscribed for different monuments, but the very distinguished gentlemen who formed the committees never seemed to get advice from a competent person as to the materials of which the monument should be made. For instance, a monument was erected of beautiful Carrara marble, and on the top of it was placed a so-called bronze statue, and the marble quickly became defaced. Why the committees which received subscriptions for public monuments did not ask for a little technical advice on such matters he did not know. He hoped nobody would ever subscribe a single penny towards the putting up of a bronze statue on the top of a marble pedestal in London. The authorities in Liverpool were much wiser; they used a beautiful red granite for the base of their statues, and thereby prevented the miserable discoloration that was obtained in the cases to which he had referred. One point raised by the author was the restrictions which were placed upon certain industries. He believed Mr. Coste was of the opinion that those restrictions should not be too hard and fast. For instance, let them take the restriction imposed on the use of petroleum. Before motors came in restrictions were placed on petroleum spirit—and perhaps, rightly so—because there were a great many accidents; but those restrictions were found to be very hard indeed when the new motor industry commenced, and had to be modified. Similar restrictions were placed on carbide of calcium. Such restrictions were too strict in many cases, the conditions imposed being unnecessary, as

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they had the effect of impeding a rising industry. He had heard that restrictions had been sought to be imposed by a Government authority on one of the most important fertilisers now being produced. The restriction was not necessary, and if it was imposed it would have a very bad effect upon British agriculture. With regard to the question of water-supply a promise had been obtained from Mr. Burns that a water board should be established throughout the whole country which would take cognisance of everything relating to water-supply. Such a board would, he thought, be an excellent thing for the unification of methods, because an enormous amount of money was wasted on litigation over points that might easily be settled. If the conditions with regard to sewage were made too rigid all progress would be stopped. The treatment of sewage at the present time was the exact reversal of what was considered the proper practice formerly. Then all fermentation or putrefaction was stopped, but the present idea was to encourage it to the utmost. Colonel Cassal was rightly indignant about the position technical chemists held, but public analysts were themselves partly to blame in the matter, because the author's figures showed very clearly that a number of them were pluralists to a most exaggerated extent. There must be a number of well-educated men trying to get appointments, and if they could not secure them in any other way they would undertake to do the work for less than they would otherwise accept if the work were better distributed.

Mr. E. Grant Hooper endorsed the remark of the previous speaker that there was a great amount of ignorance on the part of the public in general and on the part of a number of educated people, who should know better as to what chemistry really was. But personally he deprecated the author's use of the term analytical as distinct from what he called a chemical examination. He wished to remove completely from the minds of everybody the impression that an analytical operation was of the nature of a mechanical one. It was nothing of the kind. Every efficiently carried out analysis was an investigation which would be more or less elaborate according to the particular circumstances involved and the amount of money which could be spent upon it. Dealing with the question of ignorance, when a manufacturer wanted what he called a chemist, he went only too frequently to a professor, who also only too frequently undertook to supply him with a chemist in a large number of cases at £50 a year or less. To his mind, when the professor's assistance was sought in that way he should reply that he could not supply a chemist, but a well-educated chemical student. Experience in chemistry was of the utmost importance, and the very first thing that municipalities should require was training, and, secondly, experience. He would in no case permit a man to undertake responsible duties who had not obtained experience. When some trouble arose in the works, the manufacturer went to the young man to whom he was paying such an inadequate salary and expected his knowledge to be almost world-wide. Such knowledge could not be obtained without experience, and consequently a competent chemist had a width of knowledge such as very few other professional men possessed, because he could only gain it by the widest reading and study. The paper would be most valuable if it only directed the attention of the public to what chemistry really was and how much they were indebted to the chemist. Every day the chemist became more and more important. Every time a purchaser demanded quality when purchasing, he tended to insist upon the manufacturer having skilled assistance in his works, and the sooner every manufacturer on a large scale appreciated that advantage the better would his experience be in the way of profit, and the better would it be for the community at large. He had between thirty and forty years' experience of the purchase of very varied compounds, and one of the largest buyers told him on one occasion that the prices of the commodities had been reduced as the result of the advantage obtained by going to trained chemists by one-third. Large buyers found that they could, as the result of legitimate competition, get a reduction in the price of their articles equal to at least one-third. If the public realised what good chemists were capable of doing them he thought it might be hoped that the complaint Colonel Cassal had made as to the payment they at present received would be remedied, and that the chemist in the future would reap his just reward.

Mr. Noel Heaton said the author had drawn a distinction between the consulting chemist and the mere analyst, but in modern work the chemist had to be a great deal more than a mere analyst. He had to tackle all sorts of problems, and had to have resource not only to chemistry, but all the allied sciences, in order to cope with the great amount of science which was applied on the part of the manufacturers in devising methods of adulteration that the chemist could not detect. The result was, as Colonel Cassal had said, that the chemist of the present day whose duty it was to protect the public had to be a very widely-read man, and it was therefore vitally necessary he should be treated as a professional man and paid as such. He was afraid, however, it was almost too much to hope that he would be paid on the same generous scale as a legal man. He endorsed previous speakers' remarks that it was time the public were enlightened as to what the problems of the chemist were. There was extraordinary ignorance on the part of the public in this respect. It was quite a daily experience for people to bring him bits of plaster and things of that sort with the suggestion he should analyse them and tell them the next day what they were composed of. A friend of his once had a bottle of wine brought to him with the request that he would analyse the contents, and that the analysis should be sent back with the bottle of wine, which

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was required for dinner. The reason the chemist was not well paid was, he thought, because people believed he was a perfect genius, and was therefore able to feed himself without the necessity of having money to pay for the food. He endorsed what Mr. Reid had said with regard to the absence of control by the chemist in the various public monuments which were erected. Personally, he had been consulted that week in regard to a public work which was erected at great cost some years ago. Large sums of money had been spent on restoring it on two or three occasions, and as a last resource the people thought they would spend a guinea or two in getting expert advice from a chemist to put the thing right.

Mr. J. H. Coste, in reply, said he was very pleased to find there were so many points of agreement between "The Champion of Pure Food," as he thought he might call Colonel Cassal, and himself. If the Fertilisers and Feeding Stuffs Act had not prevented adulteration, undoubtedly adulteration had ceased to a large extent since the first Act was passed. The two things might have gone on collaterally without any real connection, but it was a fact that grossly adulterated linseed cake, for example, was not in existence now. That might, of course, be due to other causes than the very clumsy Acts that had been passed to deal with those matters. Colonel Cassal's suggestion of a court of reference was an extremely good one; something of that kind was undoubtedly required. He had a very vivid recollection of listening to cases in the police court where the magistrate had hardly any idea of what the point at issue was, and thoroughly disliked dealing with the cases, which stopped the ordinary course of petty justice, and generally were a nuisance to everyone. Colonel Cassal had referred to the way in which the food laws were administered in other countries. So far as Germany was concerned, he believed there were four kinds of meat—home-killed, a very fair sort of meat, and two very nasty kinds, one consisting of the flesh of animals who had died of tuberculosis, the flesh being sterilised for sale to the poor. He thought everyone present would rather analyse such meat than consume it. In reply to Mr. Reid's remarks, he thought a chemist who had to work for a public body must be somewhat of a lawyer and a good deal of a diplomatist. He must not only understand chemistry but endeavour to understand men, and to know what was possible in a world of this kind. He agreed with Mr. Reid as to the unsuitability of the materials used in London for monuments. If any kind person wished to put up a monument to him (Mr. Coste), he advised the use of either lead or platinum for the statue—lead, perhaps, would be the more modest material—and quartz for the base, because nearly everything used in London had to withstand the action of sulphuric acid. The question raised with regard to restrictions on industry was a difficult one. Personally he thought that the reasonable municipal or Government chemist would always feel that the rates and taxes were paid very largely by the people who ran big industries, and therefore that the restrictions and control should not be of a harassing and petty nature. Mr. Hooper's remarks with regard to chemical students were altogether admirable. It was most unfair to expect quite a young man fresh from college to have a great deal of experience, and, for £60 or £100 a year, to know everything. In fact, he did not. Mr. Heaton had referred to the "mere analyst." He (the author) had to use that expression, although it was one he did not like, as he was very strongly of opinion that the "mere analyst" should not exist in an independent capacity; he was really in the larval state. The only justification for the "mere analyst" was that he was young, or that he was a man whose early training was very much neglected, or that he was a man of very limited abilities. Mr. Heaton had also stated that he hardly dared to look forward to the day when the chemist would be paid as well as the legal expert. He was glad to say that had already happened, because he knew of a case where the fee given to the chemical expert was as high as that given to a very eminent counsel, who was now one of his Majesty's judges. But it was very often forgotten that a chemist was an ordinary man; that he lived by food, and that his science had not at present arrived at such a stage that he could separate proteins from the nitrogen of the air and live in that way. He did not wish to make the paper a means of touting for better pay for the profession, but the saying was just as true of the chemist as of the collier—that the labourer was worthy of his hire; and he really thought he should try and see that he got it.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Coste for his interesting paper, and the meeting terminated.

ORIENTAL CHROMOSYMBOLISM.

In a recent Note in our *Journal* on the Hindu *svastikas*, besides giving the colours of the right-handed svastika, golden, or red, and of the left-handed, silvern, or blue, green, black, or white, I gave the Hindu colours of the four conventional "quarters" ["corners," "wings," "skirts"] of the Earth and the Heavens, as they in due order wave over "the Seven Seas" between London and Melbourne, and Shanghai, in the distinguishing flag of the Peninsular and Oriental Steam Navigation Company; and this has brought me into so much instructive correspondence with various gentlemen engaged in trade with the East, and solicitous to use attractive "trade-marks" in its promotion, that I feel it will be of general interest to place on public record, in our *Journal*, all that I have written in reply to one and another of these private inquirers on the subject; and I confine myself to

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the Eastern significances of "colours,"—using the word in its popular meaning,—and say little or nothing of the Western, save by way of casual comparisons and contrasts, as we are all more or less familiar with that division, geographical, chronological, and ritualistic, of the theme. I gave the colours as I found them in use in India:—E, red; S, yellow; W, blue; and N, white or black. But they vary from this order in books. In Monier Williams, the order is:—E, white; S, yellow; W, blue; and N, red. In the "Chandrogya Upanishad":—E, red; S, white; W, blue; and N, black; and in the "Vedanta Paribasha," as I am told:—E, yellow; S, red; W, blue; N, white. The Chinese symbols of the four "quarters" are:—E, "the White Tiger"; S, "the Red Bird"; W, "the Blue Dragon"; and N, "the Black Warrior." The Hebrew names, or, at least, one set of them, of the four "quarters," have the same meaning as the names given them by the Hindu worshippers of the rising sun; that is "front" for E; "right-hand" for S; "back" for W; and "left-hand" for N; but I have never been able to get trace of any ritualistic colours for these "quarters," either in Israel, or in Islam.

The colours of "the Seven Planets," "the Eyes of the Lord, which run to and fro through the whole Earth" [Zechariah iv. 10] are, according to the Hindus:—

Planets.		Colours.
Saturn	*Sani*	Black
Jupiter	*Brishpati*	Orange
Mars	*Mangalá*	Red
Sol	*Surya*	Gold or yellow
Venus	*Sukra*	White
Mercury	*Budh*	Yellow
Luna	*Chandra*	Jasmin white

The Babylonian colouring of the planets was nearly the same, the only differences in it being that of Jupiter, purple, and of Mercury, blue. The "gems" of the Hindu amulet, the *Nava Ratna*, or "Nine Gems," that is, of "the Seven Planets," with the waxing, full, and waning Moon counted as three [compare "the triple Hecate"], are as given in the table in next column [the Persian and the Polish "gems" of the planets being given in parallel columns with them, for the sake of the suggestive agreements and disagreements between them]. This is the first time of these three sets of planetary "gems" being compared, and note, *passim*, that Katu, the Hindu name of the waning Moon, is, probably, the true source of the English name of "the Cat's-eye" of Malabar and Ceylon.

It is the "astrobolos" ["planet-stricken"] of Pliny, xxxvii. 50 (9), and, again, his "Oculus Beli" [Eye of Belus], xxxvii. 50 (10). The "Portugals" when they first reached India would have at once heard of the god Katu, and they well knew of Pliny's "Oculus Beli," and hearing also the cat everywhere in India called *beli*, they would readily give the stone the name of *Olho de gato;* and thence named by the French *œil de chat*, and by us "Cat's-eye." In Afghanistan the cat is called *pusha*, and in Southern India *pusi*, our "puss" and "pussy"; and as this name has been conjectured to be that of the Egyptian goddess Pasht, to whom the cat was sacred, and in whose worship through two millenniums it was already civilised before it was passed on into Greece and Italy, it is not impossible that its name of *beli* also was derived from that of the god Belus of Babylonia, who, according to the Greeks, was the son of Poseidon and Lybia, and the father of Ægyptus, and that it was with the cat itself transmitted from Mesopotamia into Western India, and thence overran all India. If so, if this etymology (which "Bells the Cat" ages before Archibald Douglas!) is as true as it is plausible, the harmless, half-human creature that Henriette Ronner has made in itself almost seraphic, by its three names of *puss*, *beli*, and *cat*, recalls with strange emotion the three great historical pagan religions of Chaldæa, afterwards Babylonia, and Egypt, and India.

Planets.	"Gems."		
	Hindu.	Persian.	Polish.
Saturn	Sapphire	Sapphire	Turquoise
Jupiter	Topaz	Carnelian	Carnelian
Mars	Coral	Bloodstone	Emerald
Sol	Ruby	Topaz	Diamond
Venus	Diamond	Amethyst	Amethyst
Mercury	Emerald	Touchstone	Loadstone
Rahu, waxing Moon	Moonstone	—	—
Luna	Pearl	Crystal	Crystal
Katu, waning Moon	Cat's-eye	—	—

Sarendranath Mohun Tagore sent to the Oriental Congress [Dr. Leitner's] of 1891, a collection of rings set with *white* stones for Brahmans, *red* for Kshatryas, *yellow* for Husbandmen [*ryots*], and *blue* for Merchants and Thieves. In India *red* is the colour of solemn *joy*, and of sovereign might and right, and of all reverencies; and is always worn by the Hindu women at marriages. It is also the bridal colour of China. *Yellow* is the Hindu colour of domestic and social *gladness*, and festivity, and is also worn at weddings, at least in Western India.

Among the Bretons it is the colour of mourning. *Blue*, often confused with *green* and *black*, is

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unlucky; notwithstanding that it is the colour of the merry-hearted god Krishna, whose very name means "black." Only the Sikhs in India wear blue turbans, and no Hindu will wear a blue turban; and no Hindu, Muslim, or Parsi, will complete the purchase of a sapphire until after he, or she, has worn it for a year, to test whether meanwhile it bring them weal or woe; which explains why sapphires are, comparatively, so cheap in India. Yet the Mahratta women habitually go blue-robed. A good deal seems to depend on the tint, or on the shade, of the blue. *White* is the mourning colour of the Hindus; compare Revelation vii. 13, 14:—"What are these that are arrayed in white robes? . . . These are they that have come out of great tribulation." Blue robes are worn by all Chinese, except certain Lamaists, who robe in yellow. Among the Shiah Muslims in India, and, I presume, elsewhere, *red* signifies the death of a martyr by *bloodshed*, and *green* by *poison;* and hence *green* is the colour consecrated to al Hasan, the eldest son of Ali, the cousin-german, and adopted son, of the Prophet of God, and *red* to al Husain, his younger son. Green is worn by Muslim Emirs; and Muslims who have done the pilgrimage to Mecca are entitled to wear green turbans; and a *green crescent* on a *white* flag is the proper ensign of all orthodox Muslims, *i.e.*, Sunnis. White was the colour of the Ommiades [A.D. 661–750], black of the Abbasides [*circa* A.D. 750–1258], and green of the Fatimedes [A.D. 908–1171], except in Egypt, where their colour was red. The colours of the five great orders of Dervishes are, respectively, black, green, white, red, and blue; and you can thus at once distinguish their "prayer carpets" [*jai-nammes*, "place of prayer," *sajjadah* "(the place) of prostration,"—"of adoration,"—"of self-forgetfulness" in God]. Among the Muslims of Egypt there is no mourning colour for men; but the women when in mourning dye their shirts, and veils, and handkerchiefs, and forearms in indigo blue; and in all the countries they ruled [they really rule nowhere now but in Arabia], the Muslims compelled the Christians and Jews to wear blue robes. Yellow and green are still in all Oriental countries the favourite wear of the wise-hearted, noble women of Israel.

Of curious facts of the symbolism of colours, I can recall, without being able to give accurately chapter and verse for them, these following:—Evelyn states, somewhere [in a letter to Pepys, of 1685?] that the Greeks wrapped the Odyssey in "blew," as the colour of the sea, and of voyages by sea, and the Iliad in red, as the colour of land, and of wayfaring by land, and of warfaring. Pepys says, somewhere in his Diary, that the ropes made for the Royal Navy, in his lifetime, had a single scarlet thread spun throughout their length. In the French *Tricolor*, red stands for the Capets, blue for the Valois, and white for the Bourbons; and Colonel Roy de Lachaise—with whom I corresponded on the subject—for telling his men of the 51st Infantry Regiment, in 1903, at Beauvais, of this historical fact, was incontinently retired from active service in the French Army. Our regiment of Royal Horse Guards derives its *sobriquet* of "the Blues" from having been originally raised at Oxford; a connection with the University of the "Dark Blues" that should be kept vividly alive. Both in England and in China the volumes of the lists of Government Officials in the several Administrative Departments of the State are called "Red Books!" The *cocarde*, or "cocade" worn by the rebels and their French [Bourbon] instigators during the American "War of Independence," was most appropriately consorted of black with white. I do not know the origin of the coloured bobs of our Light Infantry regiments ["Light Bobs"] as they were uniformed in the days of my youth. The black stripes in the "*dragonne*," or sword-knot, worn by Austrian officers commemorated the loss of Jerusalem in the thirteenth century to the Holy Roman Empire. The red stripes in our English military sword-knots probably have some similar meaning, apart from the obvious one, but I have never been able to unravel it out of them.

It is hopeless now to trace in any detail all this chromosymbolism to its sources; the traditions of it, in the course of the evolution of the human races, and nationalities, having become so broken up, and confused, and darkened, and too often entirely obliterated. None of it, in its origin, is likely to have been arbitrary, and all of it was most probably perfectly natural. The French say:—

"Yeux bleus sont aux Cieux;
Yeux gris au Paradis;
Yeux noires au Purgatoire;
Yeux verts—aux Enfers!"

It is everywhere in Europe a matter of popular observation, that black hair indicates a fanatical, persecuting disposition, whether in ecclesiastics, literary men, orators, or statesmen; red hair, a quick and passionate, but generous disposition; and brown hair, a sane, and temperate, and just, and steadfast, and poetic disposition.

Again, there is the new doctrine of "Warning Colours in Nature," to which the designation of "Semantics" is being appropriated. Thus it is said that the "black and yellow" colours of wasps, and the "black and white" of porcupines warn their victims from them. Surely this is putting the cart before the horse, and I would rather say that the victims were warned by the fearsome forms of these their maleficent foes.

My own general conclusion is that the symbolism of yellow, blue, and green, has become so varied, even in the historical Old World, although inhabited, over its whole historical area and time, by one and the same race of Caucasian or Noachian men, that nothing can be done to trace it back to its beginnings, and harmonise its current confusions; that the symbolism of white and black is far less varied; and that only red has almost everywhere, and perenduringly, stood for the East, *i.e.*, "the rising sun," and for all potencies and dominations, and all glories, and majesties, and for all divinities,

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from the lowliest and basest, to the highest and holiest; and justified its title of "Dominical Red." In India we owe much to its being the colour of our "Red-coats." For the full reasons of all this we have to go back to primæval hierophallic facts, and, beyond them, to deeper depths of prehistoric, nay, prehuman facts; with which, for the present purpose, I am not concerned.

In the spectrum, *the order* of the colours is violet, indigo, blue, green, yellow, orange, red. In plants *the evolution* of the colours is from green, to yellow, to red, and to blue—the perfected colour of flowers. But it means nothing apparently in chromosymbolism.

GEORGE BIRDWOOD.

THE POTATO AND BEETROOT CROPS IN FRANCE, 1911.

According to the official returns just published by the Minister of Agriculture, the potato crop in France yielded, during 1911, 11,527,900 metric tons (*viz.*, 11,346,358 English tons) from an area of 553,000 hectares (= 1,365,910 English acres), being at the average rate of 20·84 metric tons per hectare (8 tons 6 cwt. English weight). The potato crop of 1911 in France was considerably larger than that of 1910, which amounted to only 8,400,000 tons, and less than that of 1909, which was 16,700,000 tons.

With regard to beetroot, the areas cultivated, production, and yield of the various kinds grown in 1911, are shown in Table I.

The production of beetroot this year shows a considerable falling off when compared with that of the two previous years, especially as regards sugar-beet and of the kinds used for feeding cattle. This is due, in great measure, to the want of rain last summer, especially at a time when it was most needed.

To this shortage may be attributed the rise in the price of sugar, and the high prices of forage now prevailing in France.

The quantities of beetroot produced in France during the last three years are shown in Table II.

TABLE I.

	Areas Cultivated.		Quantities Produced.		Yield in	
	Hectares.	English Acres.	Metric Tons.	English Tons.	Metric Tons per Hectare.	English Tons per Acre. Tons. Cwt.
Beet for sugar-making	239,510	591,590	3,860,950	3,800,148	16·12	6 8
„ „ distilling . .	54,535	134,701	1,390,215	1,368,322	25·49	10 3
„ „ forage . .	659,300	1,628,471	14,801,040	14,567,952	22·45	8 18½
Totals . .	953,345	2,354,762	20,052,205	19,736,422	21·03	8 7¼

TABLE II.

	1909.	1910.	1911.
	Metric Tons.	Metric Tons.	Metric Tons.
Beet for sugar-making	6,250,000	5,172,420	3,860,950
„ „ distilling	1,950,000	1,900,000	1,390,215
„ „ forage	23,150,000	20,976,900	14,801,040
Totals . . .	31,350,000 or 30,856,299 English Tons.	28,049,320 or 27,607,500 English Tons.	20,052,205 or 19,736,422 English Tons.

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EMPIRE NOTES.

Imperial Commission of Inquiry.—The appointment of the Commission of Inquiry, which was determined upon by the Imperial Conference in 1911, marks an important advance in the movement towards closer commercial union between the Home Country and the Oversea Dominions. The wording of the resolution dealing with the subject indicates the comprehensive scope of the inquiry, which is to include—(1) the national resources of each of the Dominions and the best method of developing them, and (2) the ways by which the trade and commerce of each with the United Kingdom could be improved and extended under the fiscal conditions which prevail in each country. The membership of the Commission is representative of Canada, Australia, New Zealand, South Africa, and Newfoundland and the United Kingdom, in the proportion of one each for the separate Dominions and six, including the Chairman, for the United Kingdom. Lord Inchcape, the chairman, acted as Special Commissioner for the Government in China in 1901, and has served on a number of Government committees. Among the representatives of the Dominions is Sir Joseph Ward, until recently Prime Minister of New Zealand, whose opinions on Imperial federation are well known. The inclusion of Sir H. Rider Haggard, who has devoted considerable attention to the subject of land settlement, both at home and overseas, of Sir Edgar Vincent, who acted as financial adviser to the Egyptian Government, and in other important capacities, and of other well-known representative men, should ensure a comprehensive and suggestive report which may do much to bring the various parts of the Empire into closer union.

Canadian Railway Development.—The expansion of Canadian trade corresponds in a very large measure to that of railway extension. Railway construction has been the pioneer of Canadian industry. Each year the railway mileage has increased considerably, and still further developments are looked for in the future. In British Columbia, for instance, railways have been approved for a matter of 450 miles, and on Vancouver Island for 150 miles, besides many small branch lines to be constructed by the various railway companies who now have lines intersecting various parts of that Province. In Alberta the local government has announced its new policy, for which a guarantee of interest on contract at the rate of 20,000 dollars per mile, or a total of 13,000,000 dollars has been promised for three railway lines in the Peace River district. In connection with these three railways a considerable amount of swamp land will have to be crossed, which will necessitate a good deal of bridge-building. The opening up of this district is likely to prove extremely valuable, in view of the rich farming country which will now be brought within reach of markets. Throughout the prairie provinces minor lines are being extended in all directions.

Canadian Board of Trade.—The Boards of Trade of Canada discharge somewhat similar functions to those of British Chambers of Commerce, except that they are quasi-municipal bodies, and are therefore more completely representative of the trading community of their various localities. They perform very useful duties, and, by their monthly reports, do much to promote the commercial interests of the towns they serve. It is reported that one of the provincial associations of these Boards of Trade (Ontario), and probably others, will be represented at the forthcoming Imperial Chambers of Commerce Congress in London, in June next, and that an effort will be made to secure the next triennial conference of the Imperial Chambers for Canada. It is intended that the Canadian representatives shall visit the chief towns of the United Kingdom for the purpose of conferring with the various chambers in matters relating to the question of promoting closer trade relations between the Mother Country and the Dominion.

Preference for British Goods.—It is interesting to note, in view of the appointment of the Imperial Commission of Inquiry referred to in a previous paragraph, that the Government of Victoria, Australia, has decided to give preference to British goods over those of foreign countries. The step taken by the Victorian Government is the first occasion on which the principle of preference to the manufactures of the United Kingdom has received general acceptance in that State. Up to the present it has been limited to the paper required by the Government printers. A few years ago, preference was allowed to British paper-makers over those of the United States and other countries, and it has proved thoroughly effective. The new provision is embodied in the conditions of tender for State supplies, which are now being circulated, and which will be operative from July 1st next, and will hold good for three years. The proviso reads, "Preference will be given to articles of British manufacture as against those of foreign manufacture." It is further stipulated that where goods are manufactured in Australia, the raw material, when not of local production, must as far as possible be of British origin. It is specifically stated that in the case of cotton goods the articles must be all British.

A Gold Discovery in Queensland.—Etheridge, Queensland, has been prospected for gold for some considerable time, and gold is reported to have been discovered in paying quantities. The Mines Department at Brisbane has received a statement from the warden that he has visited the field. He reports that he is unable at this early date to give a definite opinion as to the prospects, but, judging by appearances, he is of opinion that it is likely

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to be permanent. The lode material consists of quartz and carries lead carbonate as well as gold. There is a large tract of country yet to be prospected, and it is doubtful at this point whether a rush is to be expected, as there is little, if any, alluvial in the gullies. The locality is some half-mile south of the Great Eastern copper mine, within a mile of the boundary of the Oaks Field. Some thirty claims have already been pegged out, and there are sixty or seventy men on the ground. Work has been started on three permanent outcrops, and it is reported that all are giving fair prospects.

New University for Western Australia.—Western Australia has for some time felt the want of a thoroughly-equipped modern university, and public feeling has expressed itself loudly in support of a project to establish one in the city of Perth. The preliminary arrangements have already been made and are now proceeding. A strong and representative senate has been appointed, and Mr. Hugh Gunn, who carried out a similar work successfully in South Africa, has taken up the work of organising the new institution. The Government has approved of the Perth Modern School being utilised for preliminary work in connection with the establishment. This school is ideally situated in extensive grounds, and, with adequate public and Governmental support, the undertaking should prove of considerable advantage to the State.

The Fisheries of South Africa.—The development of the Natal fishing industry has recently formed a subject of inquiry by a Commission appointed by the Union Government. The Commission was appointed some months ago to furnish the department of fisheries with scientific and commercial data, for the purpose of improving the industry. The report of the Commission recommends that "protection be given adult fish during spawning," "the scientific propagation of food fishes by artificial means," the "improvement of the methods of fishing," "commercial extension of the industry," and "the equipment of a Fisheries Department for scientific research." The Commission express the opinion that an expert should be appointed by the Government who should divide his time between Cape Colony and Natal. They state that they are satisfied that the oyster fisheries of Natal are capable of great expansion, and they strongly urge the scientific propagation of crayfish and crabs. There is abundant evidence that sponges of excellent quality are to be obtained all around the South African coast.

GENERAL NOTES.

International Association for Testing Materials.—The Sixth Congress of the International Testing Association, under the patronage of the President of the United States, will be held at New York, in the Engineering Societies' Building, from Tuesday, September 3rd, to Saturday, September 7th, 1912. The president of the Congress will be Professor H. M. Howe, of Columbia University. A large number of papers will be read and discussed, and arrangements are being made for visits and excursions to other cities in the United States. Members of the Iron and Steel Institute desirous of participating in the Congress can obtain further information on application to Mr. G. C. Lloyd, Secretary of the Institute.

Iron and Steel Institute.—The annual meeting of the Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, on May 9th and 10th, 1912. The following is the list of papers that are expected to be submitted for reading and discussion: (1) "Notes on the Solubility of Cementite in Hardenite," by Dr. J. O. Arnold and L. Aitchison, Sheffield; (2) "On the Chemical and Mechanical Relations of Iron, Vanadium, and Carbon," by Dr. [illegible]. Arnold. Sheffield, and Professor A. A. [illegible], (3) "Notes on a Bloom of R[illegible] from Corstopitum, Corbridge," by Sir [illegible]gh Bell, Bart., Middlesbrough; (4) "The Influence of Carbon on Corrosion," by C. Chappell, Sheffield; (5) "The Manufacture and Treatment of Steel for Guns," by General L. Cubillo, Valladolid, Spain; (6) "The Corrosion of Nickel, Chromium, and Nickel-Chromium Steels," by Dr. J. N. Friend, J. Lloyd Bentley, and W. West, Darlington; (7) "On the Mechanism of Corrosion," by Dr. J. N. Friend, W. West, and J. Lloyd Bentley, Darlington; (8) "Sinhalese Iron and Steel of Ancient Origin," by Sir Robert A. Hadfield, F.R.S., Sheffield; (9) "Modern Rolling-Mill Practice," by J. W. Hall, Birmingham; (10) "The Influence of Heat on Hardened Tool Steels," by E. G. Herbert, Manchester; (11) "Improvements in Electric Steel Furnaces and their Application in the Manufacture of Steel," by Dr. H. Nathusius, Friedenshütte, Upper Silesia; (12) "A New Process for the Investigation of Fractured Surfaces of Steel," by F. Rogers, Sheffield; (13) "The Welding Up of Blowholes and Cavities in Steel Ingots," by Dr. J. E. Stead, F.R.S., Middlesbrough; (14) "Note on some Remains of Early Iron Manufacture in Staffordshire," by Professor T. Turner, Birmingham.

Modern English Furniture at Olympia.—One of the most interesting portions of the Ideal Home Exhibition, now open at Olympia, is the section of modern English furniture which has been arranged by Mr. Dudley Heath. It contains numerous specimens of tables, chairs, furnishings, etc., made by the best of our modern craftsmen in wood. Many of these are excellent, both in design and execution, and are extremely interesting as showing t[illegible]t the best traditions of the art of furniture-m[illegible]king are far from dead. The Exhibition remains open until the 30th inst.

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Lectures on Rubber.—A special short course of lectures on rubber (from the chemical, botanical, and commercial standpoints) will be delivered in the Chemistry Lecture Theatre of the Royal College of Science, South Kensington, by Dr. Philip Schidrowitz, Ph.D., F.C.S., consulting and analytical chemist, and Mr. Herbert Wright, A.R.C.S., F.L.S., consulting economic botanist. The lectures will be given from 5 p.m. to 6 p.m. on Mondays, Wednesdays, and Fridays, beginning on Wednesday, April 24th, 1912. Applications for admission to the course should be addressed to the secretary of the Imperial College of Science and Technology, South Kensington, S.W.

The Canadian Fishing Industry.—The territorial fishing grounds of Canada, extending from the Bay of Fundy to the Strait of Belle Isle on the Atlantic coast, and from the Fraser River to Prince Rupert on the Pacific coast, together with about one quarter of a million square miles of fresh water in C[illegible] interior, constitute not only the most [illegible] the most abundantly stocked commer[illegible] waters of the world. The total value of all k[illegible] of fish and fish products taken by Canadian fishermen during the fiscal year 1909-10, was £6,000,000. This sum constitutes a record, being the highest yet reached during any one year in the history of the Canadian fisheries. It exceeds by over £800,000 the value of fish taken in the year 1908-9. This result was obtained by 1,723 vessels, steamers and tugs, five of which were engaged in fur-seal hunting, and 41,170 boats, the whole being manned by 68,663 men. Sailing boats engaged in the shore fishery are being rapidly displaced by motor-boats.

The Cotton Industry in Japan.—In spite of the high prices of raw material, the cotton manufacturing industry of Japan is in a very flourishing condition. At the present time the number of spindles there is 2,180,000, as compared with 1,274,000 in 1900, while the quantity of cotton consumed increased from 700,000 bales in that year to 1,060,000 bales in 1911. The corresponding figures for the United Kingdom for 1911 were 54,523,000 spindles and 3,782,000 bales. It will be noticed that there is a striking difference in the consumption of cotton per spindle in the two countries; while in the United Kingdom each spindle only consumes ·07 of a bale approximately, each Japanese spindle consumes nearly ·5 of a bale. The reason of this difference is to be found in the fact that as a rule the Japanese spindles are operated day and night, and are for the most part equipped with ring spindles, which consume considerably more cotton than mule spindles. According to the Bulletin on the Supply and Distribution of Cotton recently issued by the United States Department of Commerce and Labour, Japan has at present thirty-eight factories engaged in cotton manufacture, containing 17,000 looms and employing about 93,000 men, women, and children, while it is estimated that there are still about 1,000,000 hand-looms in the country, which produce about one-third of the cotton cloth used by the inhabitants. The principal source of the cotton supply is British India, although the imports of Chinese cotton is steadily increasing. The imports from the United States of America have averaged about 200,000 bales annually. Efforts are being made to increase the supply by promoting growth in Korea and Siam.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

April 24.—George Fletcher, Assistant Secretary of the Department of Agriculture and Technical Instruction, Ireland, "Technical Education in Ireland." R. Blair, M.A., B.Sc., Education Officer of the London County Council, will preside.

May 1. — William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

May 8.—E. D. Morel, "British Rule in Nigeria."

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S., will preside.

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Indian Section.

Thursday afternoons, at 4.30 o'clock:—

April 25.—Sir John O. Miller, K.C.S.I., "The Central Provinces." The Rt. Hon. Lord MacDonnell, G.C.S.I., K.C.V.O., will preside.

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Howard Lectures.

Monday evenings, at 8 o'clock:—

Captain H. Riall Sankey, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

Syllabus.

Lecture I.—April 29.—The oil engine is an internal combustion engine—Difference between light and heavy oil engines—Difference between Diesel and other heavy oil engines—Brief history of the Diesel engine—Theoretical thermal efficiency—Heat and other losses—Actual thermal efficiency

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—Efficiency ratio—Thermal efficiency compared with other internal combustion engines and with external combustion engines—Cycle of operation of a 4-stroke and of a 2-stroke Diesel engine, and essential parts to produce these cycles.

LECTURE II.—MAY 6.—Various types of Diesel engines—Considerations affecting design—Design of various parts, such as cylinders, valves, pistons, connecting rods, crank shafts, frames, air compressors, etc., for 4-cycle and for 2-cycle engines—Materials used for the various parts—Number and arrangement of cylinders for vertical and horizontal engines.

LECTURE III.—MAY 13.—Description of Diesel engines manufactured by various makers—Sizes in current manufacture and future possibilities—Speeds and weight for land and marine engines—Various kinds of oil available for Diesel engines; their characteristics, calorific value, and sources of supply.

LECTURE IV.—MAY 20.—Economical results in respect of fuel and of total annual cost—Comparison of Diesel, gas and steam engines, in respect of capital cost, fuel cost, and total annual cost—Various applications to land and marine purposes—Other heavy oil engines—Semi-Diesel engines.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 22...Post Office Electrical Engineers, Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 5 p.m. Annual General Meeting.

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. A. E. Kitson, "Southern Nigeria."

British Architects, 9, Conduit-street, W., 8 p.m. Mr. C. H. Townsend, "The Royal Institute Library and Some of its Contents."

TUESDAY, APRIL 23...Statistical, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. G. Udny Yule, "On the Methods of Measuring Association between Two Attributes."

Faraday Society, at the Institute of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Dr. E. Gumlich, "On the Magnetic Properties of Iron-Carbon and Iron-Silicon Alloys." 2. Professor E. Wedekind, "The Dependence of Magnetisation on Composition in Chemical Compounds." 3. Doctors A. D. Ross and J. G. Gray, "The Magnetic Properties of a Variety of Special Steels at Low Temperatures," and "The Heusler Alloys." 4. Doctors S. Hilpert and E. Colver-Glauert, "The Magnetic Properties of Nickel and Manganese Steels with reference to their Metallographical Composition," and "The Magnetic Properties of the Compounds of Manganese with Phosphorus, Arsenic, Antimony, and Bismuth." 5. "The Nature of the Heusler Alloys":—Dr. E. Take, "The Physical Aspect"; 6. Dr. F. Heusler, "The Chemical Aspect." 7. Professor A. A. Knowlton, "Variation of Ferromagnetic Properties of the Heusler Alloys with Composition and Heat Treatment." 8. Professor C. F. Burgess and Mr. James Aston, "The Relations between the Mechanical Hardness and the Retentivity and Permeability of Ferro-Alloys." 9. Professor Pierre Weiss, "The Magnetic Properties of the Iron-Nickel, Iron-Cobalt, and Nickel-Cobalt Alloys." 10. General Discussion on "Magnetic Properties of Alloys."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. E. Gosse, "Algernon Charles Swinburne: his Early Life and Work." (Lecture II.)

Quekett Microscopical Club, 20, Hanover-square, W. 8 p.m.

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Discussion on papers by the Hon. Sir Francis J. E. Spring, "The Remodelling and Equipment of Madras Harbour," and Mr. H. H. G. Mitchell, "The Alteration in the Form of Madras Harbour."

Photographic, 35, Russell-square, W.C., 8 p.m. Messrs. C. E. Kenneth Mees and C. Welborne Piper, "On the Fogging Power of Developers. Part II.—Determinations of the Solubility of Silver Bromide in Sodium Sulphite and other Solvents."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. Julian S. Huxley, "A First Account of the Courtship of the Redshank (*Totanus calidris*)." 2. Mrs. E. W. Sexton, "Amphipoda from Bremerhaven." 3. Mr. C. Tate Regan, "Descriptions of new Fishes of the Family Loricariidæ in the British Museum Collection." 4. Mr. Charles H. O'Donoghue, "The Circulatory System of the Common Grass Snake (*Tropidonotus natrix*)."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. A. E. Shipley, "Universities and Practical Education."

WEDNESDAY, APRIL 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. George Fletcher, "Technical Education in Ireland."

East India Association, Caxton Hall, Westminster, S.W., 4.30 p.m. Sir William Chichele Plowden, "Problems of Indian Administration."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Mr. J. Offord, "New Discoveries of Classical Literature."

United Service Institution, Whitehall, S.W., 3 p.m. Brigadier-General H. De B. De Lisle, "The Strategical Action of Cavalry."

THURSDAY, APRIL 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Sir John O. Miller, "The Central Provinces."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 8 p.m. Discussion on two Reports presented by the Tests Standing Committee:—1. "The Testing of Concrete, Reinforced Concrete, and Materials Employed therein." 2. "The Testing of Reinforced Concrete Structures on Completion."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. W. Crossley, "Synthetic Ammonia and Nitric Acid from the Atmosphere." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. E. Dawson, "Costume."

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Third Kelvin Lecture by Professor H. du Bois (Berlin).

FRIDAY, APRIL 26...Royal Institution, Albemarle-street, W., 9 p.m. Sir George H. Darwin, "Sir William Herschel."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. (Students' Meeting.) Mr. T. F. Thomson, "The Principles and Practice of Accountancy in Relation to Engineering Design and Work."

Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m.

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Discussion of Mr. H. Donaldson's paper, "The Coefficients of Expansion of Fused Silica and Mercury." 2. Mr. R. Appleyard, "The Solution of Net-work Problems by Determinants." 3. Mr. S. Butterworth, "A Method of Measuring Small Inductances."

SATURDAY, APRIL 27...Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.15 p.m. (Graduates' Section.) Mr. A. T. Thorne, "Oil Engines."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Blomfield, "The Architecture of the Renaissance in France. Lecture II.—1547-1594. Architecture and the Court."

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Journal of the Royal Society of Arts.

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FRIDAY, APRIL 26, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, APRIL 29th, 8 p.m. (Howard Lecture.) CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." (Lecture I.)

WEDNESDAY, MAY 1st, 8 p.m. (Ordinary Meeting.) WILLIAM BURTON, M.A., F.C.S., "Ancient Egyptian Ceramics." CHARLES HERCULES READ, LL.D., President of the Society of Antiquaries, Keeper of the Department of British and Mediæval Antiquities and Ethnography, British Museum, will preside.

Further details of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, April 25th; THE RIGHT HON. LORD MACDONNELL, G.C.S.I., K.C.V.O., in the chair. A paper on "The Central Provinces" was read by SIR JOHN O. MILLER, K.C.S.I.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 24th, 1912; R. BLAIR, M.A., B.Sc., Education Officer of the London County Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Halford, George, A.R.C.A., 11, Foden-road, Walsall.

Japp, Henry, 507, Fifth-avenue, New York City, U.S.A.

The following candidates were balloted for and duly elected members of the Society:—

Brandon, James Augustine, Battery House, Nepean Sea Road, Bombay, India.

Davidson, Alexander Rae, 150, Stradbrooke-place, Winnipeg, Canada.

Goodenough, Francis William, 1, Young-street, Kensington-square, W.

Groundwater, William, The Rising Sun Petroleum Company, Yokohama, Japan.

Maclachlan, Thomas, Mount Lavinia, near Colombo, Ceylon.

Payne, Harold William, Box 210, Durban, Natal, South Africa.

THE CHAIRMAN, in introducing the lecturer, said he was glad to be in the chair, because Mr. Fletcher and he were colleagues in the Science and Art Department for a good many years, and afterwards in much closer relationship as colleagues in Ireland for four years. Mr. Fletcher had been assistant Secretary of the Department of Agriculture and Technical Instruction since 1904, which meant that he was head of the branch which dealt with technical instruction in Ireland; and he (the Chairman) expected from what he knew of Mr. Fletcher, and what he knew of the subject, that the audience would hear a very interesting paper.

The paper read was—

TECHNICAL EDUCATION IN IRELAND.

By GEORGE FLETCHER, F.G.S.,

Assistant Secretary of the Department of Agriculture and Technical Instruction for Ireland.

In 1900 a great and far-reaching educational experiment was initiated in Ireland. I call it an experiment, for most people, not without some reason, regarded the work which was to develop into a system of the profoundest importance as an experiment, and as an experiment of which the success was doubtful. This movement was made possible by the passing of the Agriculture and Technical Instruction (Ireland) Act, which was placed on the Statutes in 1899, and which

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itself grew out of the work of a Committee worthy of remembrance. This Committee, of which Mr. (now the Right Hon. Sir) Horace Plunkett was chairman, and Mr. T. P. Gill honorary secretary, was known as the Recess Committee. It consisted of Irish Members of Parliament and other Irishmen of different shades of political opinion. After making extensive inquiries at home and abroad, they issued a report, which they presented to the Irish Government, recommending the establishment of a Department of Government to administer State aid to agriculture and industries in Ireland, together with the technical instruction relating thereto. A Bill was introduced by Mr. Gerald Balfour, then Chief Secretary for Ireland, and was passed into law in the same year.

The task which lay before the new Department may fairly be described as colossal. Technical education did not exist except in the large cities, while that scientific education upon which technical education can alone be based was almost non-existent in primary and secondary schools. Shortly before the creation of the new Department, the National Education Board, which is the body mainly responsible for primary education, had, as a result of the recommendations of the Commission on Manual and Practical Instruction (1898), introduced the teaching of science and hand and eye training into Irish National schools, but in Irish secondary schools the teaching of science was almost extinct. A few hundred candidates presented themselves for the Intermediate Board's Examinations in "natural philosophy," and certain specific subjects of science, but it is enough to say that these examinations were wholly written, and that laboratories did not exist in the schools. Here and there were brilliant instances of good work performed under great difficulties, but the facts I have mentioned would of themselves account for the absence of a system of technical education. There existed, it is true, science and art classes, which, scattered over the country, worked in connection with the Department of Science and Art, South Kensington, and were supported by the grants earned under its regulations; but these declined, as they were bound to do, until the amount coming to Ireland from the Science and Art grant fell to £2,819 in the session 1900–01. Those who are familiar with the history of English education will remember the great stimulus afforded by the passing of the Local Taxation Act of 1890, under which large funds were made available for technical instruction in England. Ireland's share of the local taxation duties paid to the local taxation account was not devoted to technical education in Ireland. A portion of it—£78,000—went to the Commissioners of National Education, though it was transferred to the Department under the Act of 1899. The residue was allocated to the Intermediate Board, and was devoted to general secondary education. It is not easy to say what else could have been done at the time. There was no local or central authority capable of dealing with the problem of technical education. County councils were not established in Ireland before 1898 (eight years later), and though there was power to raise a penny rate for technical education, the amount actually raised was ridiculously small—something like one-twentieth of that raised to-day. Thus for ten long years, from 1890 to 1900, while England was rapidly developing a system of technical education under the stimulus of the "beer and spirit" money, Ireland was steadily going backward.

There are, however, some points of light in this gloomy picture. Ireland has always been a lover of education. Her world-famed monastic and bardic schools, which flourished from the fourth to the tenth centuries—until their destruction, in fact—and her brilliant scholars and theologians justly earned her the title, "Insula Sanctorum et Doctorum." This love of learning, though quenched, has not been extinguished in the course of succeeding centuries, and is readily awakened by a sympathetic touch. Another advantage characterised the situation—a fairly clean slate, if not a *tabula rasa.* There were relatively few vested interests, such as beset the path of educational reformers in other countries, fewer prejudices, and a fair, if cautious, attitude towards novel proposals. To change the metaphor, the technical educator, though beset by many difficulties, had before him an untilled field and a soil which, as events have shown, was by no means unfertile. We were, moreover, able to profit by the experience gained in other countries, and thus taught to avoid the dangers and pitfalls they had encountered.

It will be necessary to say a few words as to the powers and duties conferred on the new Department by the Act.

In addition to the sum of £55,000 per annum allocated to technical education other than agricultural, power is conferred upon local authorities to raise a rate of one penny in the pound for the purposes mentioned in the Act. They already possessed the power of raising a penny rate under the Technical Instruction Act of 1889.

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Provision was also made, and this is an important point, for the transfer to the Department of the administration of the grant for science and art in Ireland, and of such powers and duties as the Department of Science and Art, South Kensington, had previously exercised in regard to the Royal College of Science, the Metropolitan School of Art, and other central institutions. The Department were empowered to give aid to agriculture and to home industries, but for other forms of industry aid was limited to educational training. There was provision for the creation of committees by the councils of counties, county boroughs, and urban districts, and also for the formation of joint committees of two or more of these bodies. These committees consist of members of the respective councils with co-opted members. Two central boards of an advisory character were to be formed, one for agriculture and the other for technical instruction, and also a larger body—the Council of Agriculture. These bodies consist of elected members, together with a certain number nominated by the Department. The Council of Agriculture is purely advisory, but the Boards control the expenditure of the Department's endowment fund.

The Board of Technical Instruction consists of twenty-one members, of whom fifteen are appointed by local authorities, one each nominated by the Commissioners of National Education and the Intermediate Education Board, while four are nominated by the Department. The Board controls the expenditure of the endowment of £55,000 for technical education, the distribution of which is subject to triennial revision. It is provided in the Act that this sum shall be divided into two portions, one of which shall be divided between the county boroughs (of which there are six), in proportion to their respective populations, the other portion being available for the rest of the country. It will not be necessary that I should explain the mode of distribution, which is partly based on population. The funds thus allocated may only be expended by the local authorities under the conditions of a scheme approved by the Department with the concurrence of the Board of Technical Instruction, and one invariable condition is the contribution of local aid to the scheme. A rate of a penny in the pound is the local contribution for all urban centres, and is the amount ordinarily devoted to the technical and agricultural schemes in the counties. Some few of the urban centres contribute more, and a few of the counties slightly less than this amount. The Department consists of a president, who is the Chief Secretary for Ireland, of a vice-president, a secretary, and two assistant secretaries (one for agriculture and one for technical instruction), with a staff paid out of a Parliamentary Vote. The first Vice-President was Sir Horace Plunkett, whose work in the cause of agricultural organisation in Ireland is well known to you. The Vice-President, under the existing administration, is the Right Hon. T. W. Russell, who represents an Irish constituency in Parliament; while the secretary is Mr. T. P. Gill, who has occupied this office since the Department was established, and was honorary secretary of the Recess Committee, to which I have referred as having cleared the way for the Act which created the Department.

Having thus briefly outlined the constitution of the Department, it will be useful to indicate one or two leading principles according to which the Department have shaped their educational administration. They were desirous from the first to develop a system of technical education in harmony with the peculiar needs of Ireland in a manner best calculated to further its industrial progress. Progress was necessarily slow for the first year or two, but the foundations were being well laid. It was realised, perhaps more clearly than in this country, that a sound system of technical education can only be erected on the broad and strong foundation of a good general education—an education which shall include the fundamental principles of science, taught practically, the aim of which is not to enable the student to pass a uniform theoretical examination, but to foster the spirit of inquiry and enable him, by means of a well-designed course of practical work, to educate his executive powers, and to give him a real insight into scientific method. The Department therefore seized upon an opportunity for reforming the teaching of science in Irish secondary schools. The great majority of these schools work under the programme of the Intermediate Education Board of Ireland, which distributes its funds in aid of secondary education on the basis of written examinations held annually. When the Department began its work the teaching of science in these schools had declined almost to vanishing point, and even that taught under the head of "natural philosophy," etc., was almost entirely theoretical in character. There were not more than five or six science laboratories in the whole of the secondary schools of Ireland. Such schools were, however, eligible for grants from the Vote for science and art teaching, the administration of which had been transferred

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from South Kensington to the Department. This Irish body, therefore, immediately formulated a programme providing for the encouragement of the teaching of experimental science, drawing and manual work, with domestic economy in the case of girls' schools. The programme provides for a four years' course in these subjects, the first two years being a preliminary course, compulsory on all schools adopting the programme, and this is followed by a two years' special course, the subjects of which are now physics, chemistry, mechanics, botany, physiology and hygiene, physical and commercial geography, domestic economy, and drawing. Any one of these may be taken and not more than three. The conditions laid down were irksome, but necessary. No school can be recognised unless it has a properly equipped laboratory, or which has not a properly qualified teacher—one who has received a training in laboratory work. Where these conditions are satisfied grants become payable on a basis which may be described as a capitation attendance-hour efficiency method. The grant, that is to say, depends upon the amount of work done and upon its excellence as determined by inspection. Examinations find no place in the Department's schemes as a means of assessing aid for educational purposes from public funds, and thus examinations are coming to occupy their due place—so far as the Department's operations are concerned—as a means of testing progress, and as providing a real test of individual ability, untrammelled by considerations of "grant." Under the Department's schemes the normal grant, as determined by the number of students and the amount of time devoted to their instruction, may be increased by one-tenth or reduced by one or more tenths on the report of the Department's inspectors. I am well aware of the risks attendant upon the delegation of wide powers to inspectors, but I may say, as a result of long experience in all types of school in England and in Ireland, that where inspectors are carefully chosen these risks become insignificant as compared with the evil consequences of assessing grants on the results of examinations. Happily this evil has ceased to exist in England.

I have spoken of the severe conditions imposed by the Department on schools desiring to work under its programme. These conditions might, indeed, have proved fatal but for two circumstances. Firstly, the enthusiasm and adaptability displayed by Irish secondary schools and schoolmasters, who welcomed the new programme notwithstanding its difficulties; and, secondly, the steps taken by the Department to solve these difficulties. The Department could give no aid for building laboratories, but they gave generous aid towards the provision of fittings and other equipment. Nearly fifty thousand pounds were thus expended, the schools providing the required accommodation. But perhaps the greatest difficulty was that of securing teachers qualified to conduct courses of instruction which involved practical work carried out almost entirely by the students themselves. This difficulty was enhanced by the fact that over the larger portion of Ireland secondary education is carried out by religious orders, the members of which, in the case of convents, are not free to attend public courses of instruction. The difficulty was met by the establishment of summer courses of instruction for teachers held in Dublin, Belfast, Cork, and other centres. In the case of convents, nuns were grouped in selected convents, which provided adequate laboratory accommodation, and specially qualified teachers sent to conduct the prescribed courses. Each course lasts nearly a month, and teachers not otherwise qualified are required to attend at least five such courses, and pass the theoretical and practical examinations at the close of them before receiving full recognition. These summer courses have now been held for the last nine years, and between 600 and 700 teachers receive instruction each year. It was the intention that these courses should only serve a temporary need, and that under normal conditions the training of teachers should be accomplished by the universities, by the Royal College of Science, the Metropolitan School of Art, and other institutions administered by the Department. We have not, however, found it desirable to discontinue these courses as yet. They have been found to serve a most valuable purpose, not only in relation to teachers in secondary schools, but also for teachers in technical schools and others engaged in various branches of the Department's work.

The results have been most gratifying. The movement was, as I have said, taken up with enthusiasm, but could never have become so general had it not been for a valuable piece of co-ordination with the Intermediate Board. Under the Act of 1899 there was established a consultative committee, consisting of representatives of the Department, the National Board and the Intermediate Board, having for its object the co-ordination of educational administration. Acting on the recommendations of the Committee, the Intermediate Board adopted the

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Department's programme to replace their own syllabus of "natural philosophy," and also accepted the Department's inspection in lieu of their own pass examination in the subjects in question. The result has been that the teaching of experimental science has been placed on a firm basis in Irish secondary schools. In the first year in which the programme was introduced 154 schools adopted it, while in the present session there are 278 schools, in 240 of which special courses are in operation, with 14,516 individual students taking science. Domestic economy is taught in sixty-two of these schools, and manual instruction in sixty-six. The total amount of grant earned in 1900–01 was £2,366, which rose to £27,955 for the session 1911–12. The work done in the schools will bear favourable comparison with that done elsewhere, and provides an excellent preparation for teaching of a technological character. I should add that drawing is compulsory in the preliminary course on all students taking science, and that in the case of schools unable to retain students for the special courses manual instruction is compulsory. This condition assists in some small degree in securing a much needed grading of schools.

The attitude of teachers towards the programme, and the excellent relations between them and the Department must be attributed in some measure to the existence of a committee of headmasters, representing various types of secondary schools, and appointed by the Department with the object of securing occasional conferences with the Department for the purpose of discussing difficulties, suggestions, and proposed alterations in the programme.

The work to which I have referred at such length, while fundamental and indispensable, is, however, not the work for which the Department was primarily called into existence. It was nevertheless a condition precedent to the operations I am about to describe. The secondary schools are administered directly by the Department, while the funds for technical education are almost wholly administered through the committees of local authorities. These bodies were invited to formulate schemes of technical instruction, and to submit them for the approval of the Department. In doing so they were aided by the Department's inspectors, who constantly confer with committees and assist them in framing and revising their schemes.

The schemes for the different counties vary considerably, but they generally contain some features in common, the Department having drawn up on a common basis schemes suited to rural needs all over the country, which are adopted by local authorities and become constituent parts of their schemes. In elaborating these the Department recognised that in rural districts little more could be done than to supplement the teaching given in various branches of agriculture, but that little was of vast importance and sought (1) to carry into the remote parts of rural Ireland such forms of technical instruction as are best suited to their needs—especially such instruction as will bear upon home-life and tend to make the countryside more bright and prosperous; (2) to give facilities for the boy of exceptional ability to continue his studies in a centre where suitable schools exist, and to direct his efforts into an industrial channel.

We have sought to realise the first of these aims by organising a system of instruction in small centres by utilising the services of itinerant teachers of domestic economy, manual instruction in wood, home industries, etc. Specially-trained teachers with portable equipment remain in a centre for a period varying from six weeks to six months, according to circumstances; the locality, where possible, provides accommodation, the equipment being provided by the Technical Instruction Committee. Classes are held daily in the afternoons and evenings, and some excellent work has been done. In the manual work classes technical drawing is taught, and the making of useful articles, such as beehives, wheelbarrows, and the like has not been found incompatible with the teaching of principles. These classes have been freely attended by young farmers and tradesmen. The courses in domestic economy include cookery, laundry-work, home-sewing, and home-nursing, and hygiene. Hundreds of these courses are held every year. There are now some 110 domestic economy teachers and eighty-five manual instructors at work in small towns and rural centres. The scheme, no doubt, possesses certain inherent defects, but I have never heard of a better one for extending the advantages of an education of this character to sparsely-populated rural areas.

A more thorough training in the duties of home life is afforded by a number of residential schools for girls, in which a carefully-planned course of instruction extends over one year. Scholarships of the value of £15 are given by a number of county committees to enable girls to take these courses. The Department directly administer one school for the training of domestic servants—the Killarney School of

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Housewifery. The Department have, moreover, aided in the establishment of three higher residential schools of domestic economy, in connection with secondary schools in Waterford, Londonderry, and Sligo, for girls who have received a good secondary education. These follow a year's course in household management.

The second of the aims referred to we seek to attain by means of scholarships. These are awarded by county technical committees aided by special grants from the Department. They are awarded by means of a competitive examination, conducted by the Department, to boys attending primary schools. Until recently, these scholarships were tenable at ordinary secondary schools, but it was found that they failed in their intention of providing a training such as would fit a boy for an industrial career. The scheme has, therefore, been revised in an important manner. The scholarships now carry a boy from the primary school to a day trades preparatory school (of which twelve have been established under a special scheme by the Department), at which he will remain for two years, and on his being apprenticed to a trade under such conditions as the Department approve, he retains the scholarship, which guarantees him a maintenance allowance of 15*s.* per week until he becomes a journeyman. An essential condition is, of course, that during the whole period of apprenticeship he shall attend an approved course of instruction in an evening technical school.

In addition to the scholarships just mentioned, there are several other types, such as the local science and art scholarships, local exhibitions, and the more valuable scholarships tenable at the Royal College of Science and the Metropolitan School of Art. There have also been a limited number of industrial scholarships affording their holders, who must be actually engaged in a trade, a course of training in the technological department of a university or other place of higher technical training.

The Department could not fail to be solicitous respecting the numerous home industries which have in rural Ireland proved so useful in supplementing the slender earnings of the peasantry. Ireland is world-famed for its laces, crochet and embroidery, and no less so for the sterling merits of its homespuns, its hosiery and many other products. In these the Department have assisted by means of grants for the salaries of teachers of drawing and design, by expert advice, and in other ways. The many imitations of these excellent products of Irish skill and industry have been flattering but not all sincere, and friends of Ireland, who desire to assist Irish industry and enrich themselves with these artistic products, will be wise in satisfying themselves beyond possibility of doubt when they ask for Irish products that they really get them. Large quantities of lace and crochet closely imitating Irish *motifs* and *technique* come from places far east of the longitude of Greenwich.

In addition to the industries which may be styled indigenous, new industries suited to the conditions of the country are being introduced. Among these may be mentioned the furniture-making industry of the "Kilkenny Wood-workers," with which the name of the late Captain Otway Cuffe will always be gratefully remembered, the glove-making industry of Tipperary, and the more recent establishment of a school of machine embroidery at Bally-dougan, near Gilford in County Down—an effort which has already given proof of success, to do in Ireland for Irish linen goods what has hitherto been done in Switzerland. Among the art crafts reference should be made to the beautiful stained glass produced by Miss Purser in Dublin, and the stained glass and exquisite enamels produced by the workers and students of the Metropolitan School of Art. It seems superfluous to add that such developments are necessarily of slow growth. It was not unnatural, though it was unreasonable, that no sooner had technical education been established in Ireland than people should ask to see proofs of its effects in increased industrial prosperity. Ireland's industries have suffered grievous wrongs in the past, and the effects of those injuries cannot be repaired in a hurry. But there are abundant signs of a rapidly-growing spirit of constructiveness, and the success of the technical schools, the creation of various industrial development associations, the local industrial shows and *Feiseanna*, all bear evidence of this fact.

As I have already pointed out, instruction in agriculture must be regarded as of paramount importance in rural districts. As in the case of technical education of a non-agricultural character, it was found that the needs of rural areas could best be met by an itinerant system. The first efforts of the Department were in the direction of pioneer lectures. These gave place to courses of lectures, and instructors are employed by county committees under the schemes for the teaching of agriculture, horticulture and bee-keeping, poultry-keeping and butter-making. There are about 130 trained

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instructors thus employed. The instructors deliver evening lectures or conduct day classes; they visit farms, gardens, poultry runs and dairies for the purpose of giving advice individually, and also conduct field or garden demonstrations. The effect of this itinerant work has been to create a demand for courses of instruction of a more thorough character than can be provided by evening lectures, and the Department is rapidly developing its scheme of winter agricultural classes. These classes are held for two or three days weekly during the period of about sixteen weeks from November to March, and in the session 1910–11 twenty-seven counties were working this scheme, there being seventy-eight classes attended by 1,339 students. For a more complete training for those who can go into residence, there are agricultural schools at Athenry, Ballyhaise, and Clonakilty; while for girls there are eleven agricultural schools, of which nine are residential. The Munster Institute at Cork, and the Ulster Dairy School at Cookstown, County Tyrone, are central institutions managed by the Department directly. The other nine are schools of rural domestic economy, and are working under private management, subject to the Department's supervision. While a number of pupils are residential, the schools are intended chiefly for girls living in the immediate neighbourhood. The principal subjects of the programme are, dairying, poultry-keeping, cottage gardening, and other branches of domestic economy.

Hitherto I have dwelt almost exclusively with our educational operations in rural areas. The growth of technical education in the towns of Ireland has been no less remarkable. No sooner were opportunities afforded for the youth of Ireland to get technical education than they crowded into the temporary buildings called schools in such numbers as to cause embarrassment. Such a result was wholly unexpected—still more unexpected the pertinacity with which they remained, and returned in succeeding sessions. All sorts of buildings were pressed into the service—private houses, disused chapels; in one place you may still find a technical school underneath a large water-tank which supplies the town with water. In another an adapted fever hospital; in another a disused gaol; indeed, disused gaols, ill-adapted for collective teaching, are a drug in the educational market. It was doubtless wise to commence in this manner, for, strange as such a statement may appear, it was necessary to show that the movement was permanent. In any case, we had to make a virtue of necessity, for the Act of Parliament which provided an annual endowment for promoting a system of technical education, made no provision for building technical schools. But, after the lapse of a few years, an altogether irresistible demand was made for more adequate buildings, and the Department was bound to approve plans and the raising of money for the erection of schools, borrowed on the security of the rate, the repayment of the principal and interest forming a first charge on the annual income of the committee. This, of course, constitutes a very serious item of expenditure, especially at a period when increased accommodation demands an expansion of the educational scheme. During the last few years, then, we have seen the erection of excellent school buildings in Dublin, Belfast, Cork, Londonderry, Waterford, and a number of smaller towns. The financial position would have been a hopeless one, but for the fact that we obtained in 1906 the sanction of the Treasury to a revised scheme for the administration of the science and art grant. This, while it produced a large increase in the income of the technical schools, enormously increased their efficiency, for the regulations under which grants might be earned demanded capable organisation and high efficiency.

The salient features of these regulations are of general interest, and may be summarised as follows:—

(1) The provision of courses of instruction based on a study of local industrial conditions designed to extend over a period of three or four years.

(2) An entrance qualification for those seeking admission to the courses of instruction.

(3) A preparatory course for those who have only a *minimum* qualification.

(4) Specialised courses for four years in commercial subjects, pure and applied science, handicraft, domestic science, and art, carrying a graduated scale of grants for successive years, depending upon the number of students and hours of attendance, and subject to an increase of one-tenth or a decrease of one or more tenths, as the Department, in consideration of their inspectors' reports, may determine.

(5) An increment grant for continued attendance up to a limit of 120 hours.

(6) Special provision for teachers' classes.

(7) A special scheme for apprentice classes, and for schools of art under which the

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Department pay three-fourths of expenditure which has been approved by them.

(8) Provision has been made during the current session for the payment of grants on a lower scale for the teaching of single subjects suited to the needs of centres too small to organise *courses* of instruction.

To this I may add that the fullest provision is made for securing that teachers should be well-qualified, and that the equipment should be adequate. The efficiency of the instruction is ascertained by inspection, and examinations find no place among the criteria for assessing the grant. At the same time, it may be pointed out that Irish technical schools have freely availed themselves of the examinations of the Board of Education (which have up to the present been conducted by the Department), of this Society, and of the City and Guilds of London Institute. The changes made in the science examinations of the Board of Education have made them unsuitable for our needs, and we are now organising a scheme of examinations suited to our own system of education.

The scheme thus briefly outlined has, on the whole, worked excellently. It allows of great flexibility, and encourages schools to adapt their curricula to local requirements. There is, in consequence, a refreshing diversity among Irish technical schools.

The question of the course system is, as in England, one in regard to which there is some difference of opinion, but of this I am sure: the scheme as it exists has been the means of bringing into clear view the aim for which both school and student is—or ought to be—striving. It has checked that aimless discursiveness and *dilettantism* which were so common when the educational *menu* placed before a student consisted of twenty-six scientific dishes (or as many of them as the school could offer), from which he selected such items as seemed most likely to suit his appetite rather than his needs. Many of us have observed the lamentable consequences of such a meal, in which digestion was confounded and assimilation impossible. The scheme I have outlined throws upon the school and the teacher the duty of ascertaining what are the real needs of the student, and of devising a course of instruction to satisfy those needs. The field of education with which we are concerned demands "intensive" cultivation, and a well-arranged curriculum must make provision of courses for its students.

The technical schools, among their other functions, are performing a useful service in the further training of teachers of primary schools. In conjunction with the Board of National Education, the Department encourage the formation of classes of teachers in their schools. This work, begun in a tentative manner in 1903–4, has greatly increased, and large numbers of teachers now attend special classes in experimental science, drawing and domestic economy. We have further framed a scheme for the training of national teachers in rural science and school gardening. The National Board undertake the payment of travelling expenses of teachers qualified to attend these courses. Where conditions make it possible, technical schools conduct centre classes in domestic economy for pupils of National schools. It will thus be seen that educational co-ordination is not unknown on the part of the bodies responsible for education in Ireland.

Reference has already been made to the trades preparatory schools, of which there are now twelve, ten being conducted by local authorities and two by the Christian Brothers in Belfast and Cork. These schools go some way towards meeting the great need for a type of school in which boys who are to follow a trade will receive, on attaining the age of thirteen or fourteen, a preparatory education designed to fit them for entering on such a career. The subjects of the curriculum are experimental science, drawing, mathematics, manual instruction, practical geometry, and literary subjects, including one modern language as well as English.

The schools are attended in the present session by about 560 pupils. It is noteworthy that boys attending these schools are in general readily "placed" on leaving. Indeed, a difficulty is experienced in retaining pupils for the full course extending over three years on account of the demand by employers for boys attending these schools.

In carrying out such a system of technical education as I have briefly described, perhaps the most important factor is that of the teacher. No educational scheme, however well devised, can work well if it neglects to make provision for the supply of duly qualified teachers, and the Department have regarded this question as one of paramount importance. Thus, in organising a scheme of manual instruction for rural and urban areas, the Department selected by means of competitive examination young tradesmen of ability, for whom they arranged special courses of instruction extending in one case over six, and in another over eight months,

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giving a maintenance allowance during the period of training. They have also held special summer courses in various cognate subjects annually for the further training of the teachers thus prepared. They have by this and other means created a corps of excellent teachers of manual work. Teachers of domestic economy are trained by means of a course extending over three years at the Irish Training School of Domestic Economy — a residential school administered directly by the Department. Teachers of science and of agriculture are trained in a course extending over three years at the Royal College of Science for Ireland, an institution whose operations can now, happily, be extended, thanks to the provision of the magnificent building which was opened by his Majesty the King in July of last year. This College provides scientific and technological instruction of university standard, and embraces faculties in agriculture, applied chemistry and engineering. Agricultural students receive a portion of their training at another of our central institutions, the Albert Agricultural College, Glasnevin, while female students and teacher students of dairy work, poultry rearing, etc., are trained at the Munster Institute at Cork.

Art teachers are trained in the Metropolitan School of Art, a Departmental school which performs for Ireland the same functions that the Royal College of Art does for England.

Teachers of lace and crochet are trained in the Cork School of Art, at which summer courses are also arranged for such teachers, while a school has been established, exclusively for the purpose of training teachers, under the Fermanagh county scheme at Enniskillen.

Teachers of commerce have been trained by means of scholarships tenable for two years, and these have been held at the London School of Economics. As a result, higher commercial training has developed in a remarkable manner during the last few years, and successful schools have been established in Rathmines, Cork, Limerick, and elsewhere. In Belfast commerce is dealt with as a section of the Municipal Technical Institute, the splendid organisation of which entitles it to rank with the finest of such institutions in the Kingdom.

DISCUSSION.

The Chairman, in opening the discussion, said it was very interesting to a London audience to carry its mind from technical education in London to technical education in rural Ireland, but it appeared that it was much the same work actually being carried on in both places. The slides had shown technical education in the rural districts of Ireland as well as technical education in Belfast. There had been represented the two phases of technical education as known in these islands. In Belfast the task was practically the same as in the great cities of England and Scotland, that was, to apply education to existing industries, whereas in the rest of Ireland the task was just the opposite, that of providing education out of which industries would develop. The second task was an infinitely more difficult one than the first. It required not only the making of an industrial population, but capital to make an industrial nation. That was the task before the Department of Agriculture and Technical Instruction when it started work in 1900. The Department consisted in the main of two branches—Agriculture and Technical Instruction. The author had sketched in the paper the work of the branch of agriculture, and he (the Chairman) thought that those who knew that branch, and the work of the Department in that respect, would probably be of the opinion that, on the whole, there was nothing in the three kingdoms like it. The author had also dealt in great detail with the work of technical instruction, that was to say, the providing of the industrial population. The Department had also a third side, the Department of Fisheries, and one or two additional pieces of work which were handed over to it by various predecessors. There were one or two points in the paper which were particularly interesting to an English audience, the first, the great difficulty with the Department of making teachers, and some importation of teachers had to be effected from England and Scotland in order to make the teachers in Ireland who had succeeded them. He thought all the English and Scotch teachers who were brought over were always able to say they had very apt material in the Irish student. Another interesting paragraph in the paper was as follows: "In the first year in which the programme was introduced, 154 schools adopted it" (experimental science), "while in the present session there are 278 schools, in 240 of which special courses are in operation." The author did not remark that a great many of those schools were private schools—private as the term was understood in England. Those private schools, in order to take advantage of the Department's grant and to place themselves at the public service in Ireland, opened themselves to public inspection. Another interesting point was with regard to scholarships to boys for learning trades: "The boy retains the scholarship, which guarantees him a maintenance allowance of 15*s.* per week until he becomes a journeyman." The author further said: "Among the art crafts, reference should be made to the beautiful stained glass produced by Miss Purser in Dublin." That was very interesting, but it required an added touch to a London audience, that a teacher—Mr. Child—was imported from the Central School of Arts and Crafts, when it had its home in Regent Street, who worked with Miss

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Purser. Further on in the paper the author stated that gaols and a distillery had been turned into technical schools. That was somewhat of a triumph. There had been very little reference in the paper to the work of the primary schools. He (the Chairman) did not think there had been a very great change in that respect since he was in Ireland, but one looked forward with great hope in the near future to a great alteration in primary instruction in Ireland. In conclusion, he was glad to notice among the audience a good sprinkling of men who had had to do with the Department's work, and he hoped they would take part in the discussion.

MR. M. J. FLAVIN, M.P., said he was glad of the opportunity, as one who had been connected with technical education in Ireland, to testify to the good work the author and the Chairman had done. His one regret was that Ireland had lost Mr. Blair's valuable services; but that country's loss had been London's gain. The audience had had a real picture of Irish industrial and technical life that night, and he could publicly testify as a Member of Parliament to the great work that had been done, both in agricultural and technical instruction by the Department. All he could say was, "God speed the good work!" He was extremely glad to see that gaols were being converted into technical schools, and he thought that spoke very well for the prosperity, peace, and quietness of Ireland. He did not even regret that a distillery had also been converted. He hoped the good work the Department was doing would progress, as there was plenty of room in Ireland for it.

MR. ALAN S. COLE, C.B., said the constitution of the Board of Agriculture and Technical Education in Ireland had clearly focussed under one administration a number of various forms of aid that were being given previously by the State through different channels; and a great deal of interesting history in connection with them might be gathered from the forty odd annual reports from the old Science and Art Department, in whose service it should always be remembered that many of the greatest men versed in science, art and technical work took part—men like Huxley, Tyndall, Hoffmann, Leighton, William Morris, and many more. Whatever might be the value of their views when compared with those current now, no one would question the indebtedness of the present to the past. In the past, things were in a way possibly more of an experimental character than now. Still, much of the Board of Agriculture's scheme of scholarships, courses of instruction, itinerant teachers, special trade teaching, seemed to him to be direct and wise developments from what existed of a closely similar, if not identical, nature, and to make for a stage beyond experiment. There had obviously been a prolonged activity in the matter of technical education in Ireland, and the Board had in a short time earned a reputation for continuing such activity. After listening to Mr. Fletcher's very lucid and interesting paper, he was sure that it would strike all that the Board, fortunately having his services at command, was pursuing a clear course towards success. The only justification he had for taking part in the discussion was that some years ago he had been called upon to frame and work out some scheme of technical education in favour of lace-making, embroidery and the like in Ireland. That was when he was on the staff of the old Science and Art Department at South Kensington, which Department was approached by certain Irish Members of Parliament interested in the Irish industry of lace-making. For some fifteen years, 1885 to 1900, he visited Ireland usually twice a year, lectured on design, conferred with teachers and pupils, with workers and employers, and he learnt much of the admirable aptitude of the Irish in various cottage or home industries, their versatility, and quickness of appreciation; at the same time regular and ready application of what seemed quickly appreciated was not so apparent to him. That led him to try and get at centres or groups of people engaged in the lace industry where there was something definite in the way of organisation and promise of permanent existence. Many of such centres were at convents, and it was gratifying that a good many of them readily adopted suggestions he was authorised to put before them. They improved their provision to cultivate taste and application, power of design, thoughtfulness and the like, not only in their younger pupils, but also in the adult workers who came to their premises to execute orders for trade purposes. As far as the rules of the Science and Art Department permitted, grants to pay for improved equipment, teaching, and even to build new rooms, were given; and he hoped that the Board of Agriculture found work at these convents to be progressive. He knew that from the point of view of wages and sales in connection with lace-making, Youghal, Kinsale, and Sligo were doing well. But besides the Government grants from the Science and Art Department, funds were provided through the gracious generosity of H.M. the late Queen Victoria, Lady Londonderry, Lady Aberdeen, Mrs. Alfred Morrison, and several others, including a few of the City companies; and by means of these funds a number of experiments were caused to be carried out by adult workers in various parts of the country, whether they were working under committees of private persons benevolently interested, or under convents or traders. Some of the experiments were absolutely successful and notable, some were not; whenever earnest endeavour had been made it was paid for, so that the worker suffered no loss of wage. The influence upon the wage-earning lacemakers was, he thought, valuable. It made them think, and set them to do things which they had not contemplated. Something of that sort was done later on—about

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1897—in Donegal, by the Congested Districts Board. He was not sure, from what he had heard that evening, whether the Board of Agriculture in Ireland undertook work of the same definite character in touch with wage-earning laceworkers and embroiderers. He realised that it was a form of encouragement that might be held to infringe the doctrine of *laissez faire;* however, in regard to the experiments he had alluded to, he certainly thought that if there were any such infringement it was justified by results, and he hoped that the giving of commissions for the production under efficient check and supervision, of bits of work from prescribed and, if necessary, actually provided designs, might lie within the powers of the Board.

MR. F. G. OGILVIE, C.B., remarked that, since he came to know the work of technical education in Ireland at all intimately, he had always found it to be a work of most absorbing interest, and one which was most fruitful in suggestion; and quite apart from any mere question of what were the details that had been applied in this, that, or the other section of the work—for the sections of the work would have to be counted by hundreds—nothing was more hopeful, within his knowledge of Ireland, than the rapidity with which the Department of Agriculture and Technical Instruction was able to cover the country with a web of most effective educational influences. The work had to be started in almost all the districts of Ireland in so far as it referred to matters connected with trade and industry, other than home industries and those which had been continuously represented in certain large centres. As there were so many sections, it was quite obvious one could not do any more than say that it would be well to look in some detail at the returns and specifications of work done in the different regions. These had been carefully adapted to the special circumstances—the special needs, the special possibilities, and also the special limitations—of the field that had to be occupied. The author had touched upon the work done with regard to the training of teachers. That he (the speaker) considered to be one of the most marvellous, as it was one of the earliest, successes of the Department. Obviously such work in Ireland as had been mentioned in the paper could not have been done unless there had been an adequate corps of teachers. The importation of teachers was reduced to a minimum. It had been kept down by taking a few men of special types and endeavouring to make them centres of instruction. There was one point which had struck him, but which had not been touched upon by the author. He thought not the least important of the results of the work of the Department had been a by-product—the technical education of local authorities in the duties of local government, because he felt sure that the power which was entrusted to the very large number of small committees who had not previously had the opportunity of taking part in local affairs closely related to the welfare of their districts, the assistance given to these in the exercise of that power, and the judgment with which the assistance was given, must have been of the utmost possible value in the development of local responsibility. He had been struck with the rarity of cases of committees acting, as such committees sometimes did act in countries that had long had local government, rather stupidly, or even pig-headedly, or otherwise not for the public good, and he felt that one of the greatest attributes to the excellence of the work done by the Department was the smoothness with which their committees worked, and that their committees did do the work which committees ought to do in the various localities. He was very glad to notice that the work had been progressing in such a way during the years Mr. Fletcher had been wielding the sceptre after Mr. Blair.

MR. E. M. RICH said it had been his duty to look at some of the remaining classes which were conducted under the Science and Art Department in Ireland, and he could assure those present that the difference in the condition of the classes in 1900 in important centres like Belfast and Londonderry, and their condition at the present time was astonishing. One of the very earliest classes he saw was a class in mechanics in Belfast. It was attended by some three or four students sitting in an extremely uncomfortable room, very badly lit, and with practically no apparatus. The audience had seen that night on the screen rooms crammed with artisans. An extraordinary development had taken place in education in Ireland during the last ten years. In conclusion, he might mention that he had spent four years of extremely interesting experiences and great hospitality while he had been resident among the Irish people acting as an inspector of the department.

MR. M. HICKS said he could not help feeling that much of the paper which had been read that evening was of the character that must eventually make for the splendid system of education in Ireland. The author had shown that a good general education had been taken as the basis of the training, and he (the speaker) thought, unless they built on that firm rock, money and time would be wasted, and disappointment would ensue.

MR. GEORGE FLETCHER, in reply, said the remarks which had fallen from the various speakers had made him more painfully conscious than he had been before of many omissions in his paper. He had, however, been bound to omit a great deal. Because he was dealing with technical education he had only referred to the educational work of the agricultural branch, and had not mentioned the Fisheries, or the Statistics, or the Intelligence branches of the Department. He would

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also have liked to have referred to many of the agencies for assisting teachers, and the loan collections and the numerous exhibitions which had been organised, but all that had to be left out. The Chairman had referred to the stained-glass work in Dublin, and to the bringing over of Mr. Child. He would be glad to learn that Mr. Child was still doing his useful work, and there was an excellent piece of co-ordination in that respect between the Metropolitan School of Art and that little industry. He desired to thank Mr. Flavin for his very kindly remarks. He knew Mr. Flavin's keen and fiery interest in the cause of technical education. Mention had been made of the committees in Ireland. It was not an easy business to meet such committees—they had a way of speaking their mind. But it was worth it. Personally, he had gone through many bad fights with county committees, and he was rather thankful for the experience. One thing he could say truly about the Irish committees, and that was they were perfectly in earnest about their work. It was remarkable in how short a time they got into working order, and there were many examples of most unselfish service to the cause of technical education all over the country. Mr. Cole had raised one interesting point among many, namely, as to whether the Department had maintained any sort of connection with wage-earning workers. It had certainly done so. Happily the Department had very great powers in regard to home industries, and they rather made that a point. They had shut down ruthlessly certain lace classes that were established in urban centres and were of a dilettante nature. The Department aimed definitely at wage-earning in these rural classes. In County Fermanagh there was a very highly-organised system of something like a dozen county teachers of lace, crochet, sprigging and such like. Classes were organised, and they brought in many thousands a year for the workers. There was nothing to prevent the Department from doing that, but it could not give direct aid to industries other than home industries, and those had been rather carefully defined. He ought to say that the Department went just as far as it could in the way of paying for educational training. Mr. Ogilvie was quite right in pointing out the results of the technical education of local authorities. He (the author) was extremely thankful that the Bill was framed on such lines as to make its administration through local committees a necessity. He did not believe the cause of technical education could ever have obtained a hold on public confidence in Ireland unless it had been administered through local committees. With regard to the importation of teachers, that of course was inevitable in the beginning. It followed that, as the work proceeded, Ireland would be able to supply its own teachers. At the present time there were between three and four hundred itinerant teachers engaged over the country under various schemes, and almost without a single exception they were Irish.

The Chairman, in moving a hearty vote of thanks to the author for his interesting paper, said Mr. Fletcher had always had the happy faculty of placing his knowledge before his audience in a very interesting way, and that was one of the faculties which had enabled him to get on so well with the Irish county committees. Mr. Fletcher had what the Englishmen and Scotchmen did not often have, a quick and ready tongue, but with no irony in it; and nothing could be more useful than that before an Irish audience. While taking their work seriously to heart they enjoyed a flavour of humour, and he was bound to say that some of that flavour of humour might help much of the committee work in England.

The vote of thanks was carried unanimously and the meeting terminated.

THE IDEAL HOME EXHIBITION.

At the *Daily Mail's* "Ideal Home Exhibition," at present being held at Olympia, may be seen the conveniently planned "Ideal House," designed by Mr. Reginald C. Fry, in conjunction with Mr. H. Clarke, jun., and erected by Messrs. H. and E. Taylor in the remarkably short period of nine days. Mr. Fry's design and plans, it will be remembered, won the prize in the Ideal Homes Competition, for which nearly 800 architects entered. The house, which has been erected at Olympia at a cost of £1,100, consists of lounge-hall, dining-room, drawing-room, kitchen, scullery, pantry, and cloak-room on the ground floor; and five bedrooms (all with cupboards), bath-room, and dressing-room on the first floor. The servants' bedroom is accessible from the kitchen by a convenient back staircase, and the front door can also be approached from the kitchen through the pantry. Throughout, special attention has been paid to the natural lighting of the various rooms, and the architects have skilfully contrived that all the reception-rooms shall have a south aspect for their principal lighting, while every bedroom has at least one window facing the south-east. In addition to this very popular exhibit there are also erected in the main hall at Olympia the stalls of numerous commercial firms who deal in domestic appliances. Heating, lighting, decorating, furnishing, sanitation, hygiene, cookery, are all represented, and in some cases labour-saving devices, and here inventions or improvements suitable for domestic uses may be seen in actual operation. In the large gallery, in addition to a fairly representative section devoted to the arts and crafts generally, may be found what is perhaps the most interesting feature of the exhibition—a show of modern European furniture, the English section of which has been arranged for the directors by Mr. Dudley Heath. Here can be viewed—necessarily in somewhat confined space—a pleasing series of rooms illustrating the work of some of the

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best present-day English craftsmen in wood. Among the exhibitors here are Romney Green, Ambrose Heal, Malcolm Powell, Hamilton T. Smith, Charles Spooner and C. F. A. Voysey; and in particular we noticed a wardrobe in English walnut of beautiful design and workmanship by Mr. Hamilton Smith, who also shows an oak side-board of very good appearance and admirably adapted to its purposes. Throughout the whole of this section, even where the design may not appeal, one is uniformly struck by the very high level of the workmanship. The ease with which drawers pull out and in, and cupboards open and shut, might well satisfy the ideals even of the famous eighteenth-century workers. The pieces of furniture (handmade for the most part, although the craftsmen have not hesitated to use machinery where the workmanship did not suffer), too, compare in many cases not unfavourably in price with the machine-made articles of commerce, so that we are surely justified in hoping that the ugliness and bad workmanship to which nineteenth-century methods have made us accustomed, may slowly grow in disrepute.

OBITUARY.

Thomas Colby.—The Society has lost its oldest member by the death, on the 4th inst., at the age of eighty-two, of Mr. Thomas Colby, who became a Life Member of the Society as long ago as 1850. Mr. Colby was a student of the University of Bonn from 1849 to 1852, when he studied chemistry, mathematics and mechanics. He also took part in special magnetic observations at the Bonn Observatory, under Dr. Arzelander. In 1856–7 he patented a process for manufacturing pearl-ash (potassium carbonate) by agitating barium carbonate with potassium sulphate, using large quartz pebbles as a grinding agent in the mixture, which was contained in large wrought-iron revolving drums. The process was carried on at the Posket Nook chemical works, St. Helen's, Lancashire, and the pearl-ash was used at Messrs. Bishop's glass-works for the finer quality of glass. The financial results of the manufactures were, unfortunately, unsatisfactory, and in 1858 Mr. Colby took to farming his own property in South Wales, which he continued to do up till the time of his death.

NOTES ON BOOKS.

On the Backwaters of the Nile. By the Rev. A. L. Kitching, M.A. London: T. Fisher Unwin. 12*s.* 6*d.* net.

Mr. Kitching has spent ten years as a missionary among the outlying tribes of the Uganda Protectorate. He is already known as the author of an outline grammar of the Gan' language, which is spoken by the people who dwell between the Albert Lake and the Victoria Nyanza. He possesses that knowledge of medicine without which no missionary should venture into the wilds; he is a good sportsman, a bit of an architect, carpenter, and handyman; and when it is added that he is a keen photographer and writes in a style which (save for an inordinate passion for splitting his infinitives) is excellent in its terseness and lucidity, it will be seen that he is admirably qualified to give an interesting account of the savage races among whom he has lived so long.

The Gan' appear to be very typical specimens of what Mr. Kitching calls the child races of Central Africa. Living under a tropical sun in a country which provides them with sufficient food at a minimum of labour, they—at all events the men; the women are compelled to do a certain amount of work in order to support their husbands—are among the laziest of mankind. "To be able to say, 'I have no work to do,' is to attain happiness, and no feature of English economy is more incomprehensible to the African mind than the very suggestion of such a measure as a 'Right to Work' Bill." At the same time they are—like most primitive peoples—extraordinary gluttons, and the monotony of their meals, which for the most part consist of millet porridge twice a day, induces such a craving for meat that a special word *amairu* is used to express it, a word which has no equivalent in English. In the pursuit of game—and game must be taken to include such small deer as rats, grasshoppers, and ants—they are capable of enduring great fatigue if there is the prospect of an unlimited gorge at the end of it. The greatest defect of all European meals to the African is that there is not nearly enough. "Quantity, not quality, is what appeals to him, and I have often heard it said that 'Europeans do not know how to eat!' The native expects literally to *feel* full after a good meal, and no worse disgrace could be incurred by a host than to let his guests go away capable of eating another mouthful. The correct condition at the conclusion of a feast was accurately and graphically described by a chief at a native reception to celebrate a European wedding: 'Another morsel would be death!'"

Mr. Kitching has an interesting chapter in which he discusses some of the difficulties in dealing with a language so unlike one's own as the Gan' dialect. "None of the words exactly correspond to English ones, and the words you want most have probably no equivalent at all in the language to be studied. So it frequently happens that the same word will be given you for two ideas apparently inconsistent." Thus in a tentative booklet which Mr. Kitching found in use among the missionaries when he first went into Uganda, God was translated by a word which, as he afterwards discovered, meant "hunchback." Other errors arise through the difficulty of the interpreter, who at first is necessary, to pronounce the words you are studying. A boy of another tribe was endeavouring to carry on a conversation

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in the Gan' language on the subject of ravenous beasts, including the lion. The Gan' word for lion is *labwor*, but owing to the peculiarities of his own tribal phonetic laws, the boy pronounced this as *labolo*, the Gan' for a banana plant. As the result of this confusion the boy was found to be discussing the possibility of a member of the caravan being carried off in the night by a banana plant.

One of the great characteristics of the young men of the Gan' tribe is their passion for self-adornment. In the almost entire absence of clothes, recourse has to be had to fashions with which Paris and London are unfamiliar. One of the photographs represents three young bloods who have plastered their hair in great chignons, using cowdung as pomatum. Into these all manner of ornaments, such as feathers, hogs' tusks, and metal rings, are thrust. A bit of looking-glass is frequently worn on the forehead, and happy is the youth who can thrust a pencil of glass through his underlip. But perhaps the most remarkable adornments are the tight bracelets of metal which you must wear if you would be a blood. No lady of fashion in Europe was ever called upon to endure the agonies which these bracelets cause. So tight are they that arms are often ulcerated, and muscles distorted for life; indeed, Mr. Kitching describes one terrible case in which two iron rings, each an inch thick and perhaps two pounds in weight, had become buried in the flesh so as to be partly invisible. The pain that must have been caused for years before such a state of things could have become possible is almost inconceivable.

It has been mentioned that among the Gan' clothes are almost unknown. Cheap calico trousers have, however, made their appearance during recent years, though they are not always worn in the fashion usual in civilised countries. If a native is on a journey, he will very probably wrap them round his neck, partly in order to save them, partly, no doubt, because it is more comfortable to walk in a state of nature. They have other uses, too. If the ends of the legs are tied up, the trousers make an excellent double sack, very convenient for carrying flour, etc.

Mr. Kitching has written a very complete and graphic account of the Gan' people; the book is illustrated by nearly sixty photographs taken by himself, and a good map, and it will be read with keen interest by all those who take pleasure in the study of primitive races.

A B C OF HYDRODYNAMICS. By Lieut.-Colonel R. de Villamil, R.Eng. (retired). London: E. & F. N. Spon, Ltd. 6*s*. net.

In this book the author hopes to be able to relieve the beginner of difficulties which would otherwise beset him in his study of hydrodynamics. His aim is to show that ordinary liquids follow the same laws as the "perfect liquid" of the text-books, and under similar conditions move in a similar manner. The beginner who has here his A B C is supposed to have proceeded some way in the reading of the usual text-book. The scheme of the book involves its author in a large amount of quotation, which must either require in the conscientious reader a continual reference to his authorities or imply in him a knowledge of the subject distinctly beyond the A B C. Yet Colonel de Villamil has given us an introduction dealing with the first principles of hydrodynamics which cannot fail to engage the attention of the student. Whether he may eventually prove to have simplified his subject or not, it must be said that at some points he suggests attractive explanations. To take a slight example, in the chapter on a viscous fluid flowing "by obligation" there is outlined what he considers may be the first stage in the formation of vortices; the diagram given by Lord Kelvin in his paper on "Coreless Vortices" being the second stage.

The summary given at the close of each chapter is a decided advantage to the reader, who too rarely finds such consideration.

GENERAL NOTES.

THE INSTITUTE OF METALS.—The third May lecture of the Institute of Metals will be delivered at the Institution of Mechanical Engineers, on May 10th, by Sir J. Alfred Ewing, K.C.B., F R.S., the subject being "The Inner Structure of Simple Metals." The chair will be taken by Professor W. Gowland, F.R.S., President of the Institute. Members of the Royal Society of Arts who desire to be present should apply for tickets to Mr. G. Shaw Scott, M.Sc., Secretary, Institute of Metals, Caxton House, Westminster, S.W.

THE HARVEST OF CEREALS IN ALGERIA, 1911.—The returns showing the results of last year's harvest in Algeria have just been published by the Government of that colony. They show a shortage in the wheat crop of 953,000 quintals (1,875,984 cwts.), as compared with that of 1910, which was an exceptionally good one. The total production last year was 9,763,000 quintals (19,218,504 cwts.) against 10,716,000 quintals (20,094,488 cwts.) in 1910. The production of barley during 1911 was slightly inferior to that of 1910, being 10,361,000 quintals (20,395,669 cwts.) and 10,605,000 quintals (20,875,984 cwts.) respectively. The quantity of oats grown in the colony was small, when compared with that of the wheat and barley, being 1,692,000 quintals (3,330,708 cwts.) only.

MEXICAN VANILLA.—As far back as the time of the Aztecs the vanilla was used to spice the chocolate. Vanilla, or, as the Spanish word is spelt, "vainilla," is a kind of climbing tropical orchid with thick leaves, and spikes of large and not very beautiful flowers. The Spaniards, quick to see the value of vanilla as

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an article of export, began the cultivation of the aromatic pod. For a long time the former province of Vera Cruz supplied the whole world with vanilla, until the Bourbon Islands and Java waged competition against it. The vanilla of Mexico is the superior of all other varieties as to aroma, and the pod yields a much larger quantity of essential oil. In the markets of the United States about one fourth of the imports of vanilla beans comes from Mexico, at two or three times the price paid for the product of other countries. Vanilla is to a large extent cultivated in plantations, on damp but not swampy or muddy lands, in the tropics, where the necessary shade can be secured, a condition found in all the States contiguous to the Isthmus of Tehuantepec. The plant begins to yield thirty-nine months after planting, and continues to yield during ten to twelve years. The average yield is from ten to twenty pods to a vine, artificial fertilisation producing much more. The cultivation of vanilla has many advantages, among others the fact that corn crops can be grown in conjunction with it, while on coffee plantations it can be made to play a secondary but profitable part.

Bulletins of the International Institute of Agriculture. — The Society has received, through the kindness of the Board of Agriculture and Fisheries, eight volumes of the Bulletins published by the International Institute of Agriculture, Rome. Three of these are issued by the Bureau of Agricultural Intelligence and of Plant Diseases, and five by the Bureau of Economic and Social Intelligence. The intelligence contained in each volume is taken exclusively from the books, periodicals, bulletins, and other publications which reach the Library of the International Institute of Agriculture during the period covered by the volume. It is thus gathered from an immense number of sources, not a few of the articles being reprinted from this *Journal*. The edition which has been received by the Society is entirely in English, articles from French, German, Italian and other foreign publications having been translated by translators attached to the Bureau. The information contained in the bulletins is of a very varied description, and the publications should prove of great value to all interested in agriculture.

Cotton Cultivation in Turkestan. — The Russian Government has been assisting in many ways the growers of Trans-Caspian cotton. It appears from official reports that, in the autumn of 1910, the Agricultural Department organised the first cotton-seed plantation in Turkestan. In 1911 one such station was working in the Namangansk district of the Ferghana Oblast, covering an area of 53 dessiatines (about 143 acres). Here three systems of cultivation were applied. First, by machinery only, the seeds being sown in rows, and the soil between the rows ploughed; secondly, by using both machinery and hand labour for sowing, but working the soil between the rows; thirdly, by manual labour only, the natives being employed. The best results from the point of view of an abundant crop were achieved by relying entirely on machinery, the results being 8,613 pounds per dessiatine (2·7 acres) for machinery, 5,556 pounds for machinery and labour and 4,921 pounds for hand labour alone. Manure was used in the first instance only. The average crop of cotton obtained on the plantation amounted to 3,692 pounds per dessiatine, but a second crop of 540 to 720 pounds is expected, so that the average for the station for 1911 may be estimated at about 4,300 pounds.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

May 1. — William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics." Charles Hercules Read, LL.D., President of the Society of Antiquaries, and Keeper of the Department of British and Mediæval Antiquities and Ethnography at the British Museum, will preside.

May 8.—E. D. Morel, "British Rule in Nigeria." Sir Edouard Percy C. Girouard, R.E., K.C.M.G., D.S.O., late Governor of Northern Nigeria (1908–9), and of the East African Protectorate (1909–12), will preside.

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S., will preside.

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture."

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Howard Lectures.

Monday evenings, at 8 o'clock:—

Captain H. Riall Sankey, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

Syllabus.

Lecture I.—April 29.—The oil engine is an internal combustion engine—Difference between light and heavy oil engines—Difference between Diesel and other heavy oil engines—Brief history

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of the Diesel engine—Theoretical thermal efficiency—Heat and other losses—Actual thermal efficiency—Efficiency ratio—Thermal efficiency compared with other internal combustion engines and with external combustion engines—Cycle of operation of a 4-stroke and of a 2-stroke Diesel engine, and essential parts to produce these cycles.

LECTURE II.—MAY 6.—Various types of Diesel engines—Considerations affecting design—Design of various parts, such as cylinders, valves, pistons, connecting rods, crank shafts, frames, air compressors, etc., for 4-cycle and for 2-cycle engines—Materials used for the various parts—Number and arrangement of cylinders for vertical and horizontal engines.

LECTURE III.—MAY 13.—Description of Diesel engines manufactured by various makers—Sizes in current manufacture and future possibilities—Speeds and weight for land and marine engines—Various kinds of oil available for Diesel engines; their characteristics, calorific value, and sources of supply.

LECTURE IV.—MAY 20.—Economical results in respect of fuel and of total annual cost—Comparison of Diesel, gas and steam engines, in respect of capital cost, fuel cost, and total annual cost—Various applications to land and marine purposes—Other heavy oil engines—Semi-Diesel engines.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lecture.) Captain H. R. Sankey, "Heavy Oil Engines." (Lecture I.)

Aeronautical Society, at the Royal United Service Institution, Whitehall, S.W., 8.30 p.m. Captain C. H. Ley, "Aerial Topography."

Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. T. Loban, "Some Principles in the Valuation of Land and Buildings."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. 1. Messrs. H. W. Manly and T. G. Ackland, "On the Superannuation and Pension Funds of certain Metropolitan Borough Councils, their Establishment, Administration, and Actuarial Investigation." 2. Mr. L. E. Clinton, "Tables of Progress of Typical Funds for Officers and Workmen, and Examples."

TUESDAY, APRIL 30...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. Graham Wallas, "Syndicalism."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. B. Brown, "Insect Distribution, with special reference to the British Isles." (Lecture I.)

Economics and Political Science, London School of, Clare-market, W.C., 6 p.m. Professor H. Levy, "Die Volkswirtschaftliche Entwicklung Englands und Deutschlands" (in German). (Lecture I.)

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. W. Fincham, "Mont St. Michael, the Abbey of the Archangel and its Sea-girt Town."

Civil Engineers, 25, Great George-street, S.W., 8 p.m. Annual General Meeting.

WEDNESDAY, MAY 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Burton, "Ancient Egyptian Ceramics."

Geological, Burlington House, W., 8 p.m.

Public Analysts, at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. W. L. Austin and C. A. Keane, "The Analysis of Lithopone." 2. Messrs. C. O. Bannister and W. McNamara, "The Effect of Calcium on the Ammonium Molybdate Lead Assay." 3. Messrs. J. W. Agnew and R. B. Croad, "The Constituents of Oil of Savin." 4. Mr. W. B. Pollard, "The Detection of Heavy Petroleum in Paints and Vegetable Oils."

United Service Institution, Whitehall, S.W., 3 p.m. Captain R. J. Kentish, "The Case for the Eight-Company Battalion."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Dr. A. C. Fryer, "The Monumental Effigies of Nicholas Stone."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Hon. W. P. Reeves, "Land Taxation in relation to Land Tenure in Australasia."

Royal Institution, Albemarle-street, W., 5 p.m. Annual Meeting.

THURSDAY, MAY 2...Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Miss T. L. Prankerd, "The Structure of the Palæozoic seed *Lagenostoma ovoides*, Will." 2. Dr. Karl Domin, "Additions to the Flora of Western and North-Western Australia." 3. Mr. G. H. Wailes, "Freshwater Rhizopoda from the States of New York, New Jersey, and Georgia, U.S.A.; with a Supplement on a Collection from the Seychelles." 4. Mr. W. M. Webb, "*Ligidium hypnorum*, a Woodlouse new to Britain." 5. The General Secretary, "New Light on the Linnean Herbarium."

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. F. H. Carr and W. C. Reynolds, "Nor-hyoscyamine and nor-atropine. Alkaloids occurring in various Solanaceous Plants." 2. Mr. A. H. Salway, "Researches on the Constitution of Physostigmine." (Part I.) 3. Mr. T. S. Moore, "The 'true' Ionisation and Hydration Constants of Ammonia and some Amines, with a Note on the Formulation of Nitrogen Compounds."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. Norman Collie, "Recent Explorations in the Canadian Rocky Mountains." (Lecture I.)

Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Adjourned discussion on "The Causes Preventing the More General Use of Electricity for Domestic Purposes."

Economics and Political Science, London School of, Clare-market, W.C., 3 p.m. Miss Barbara Freire-Marreco, "The Self-Government of the Pueblo Indians under Spanish and American Administration." (Lecture I.) 5 p.m. Miss Mabel Atkinson, "The Consumption of Wealth in the Different Sections of the Community." (Lecture I.)

FRIDAY, MAY 3...Royal Institution, Albemarle-st., W., 9 p.m. Mr. W. C. D. Whetham, "The Use of Pedigrees."

Economics and Political Science, London School of, Clare-market, W.C., 5 p.m. Professor J. H. Morgan, "The Legal Basis of the Government of England and Ireland." (Lecture I.)

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. Discussion to be opened by Professor J. O. Arnold on "The Tenth Report to the Alloys Research Committee on the Alloys of Aluminium and Zinc."

SATURDAY, MAY 4...Economics and Political Science, London School of, Clare-market, W.C., 12 noon. Dr. C. Bougle, "Les Etapes du Mouvement Social en France au Dix-Neuvième Siècle" (in French). (Lecture I.)

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Blomfield, "The Architecture of the Renaissance in France." Lecture III.—1594-1661. Architecture and France."

Municipal and County Engineers, Public Hall, Exmouth, 11 a.m. (South-Western District Meeting.) Mr. S. Hutton, "A Decade of Progress in a Residential Seaside Town."

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Journal of the Royal Society of Arts.

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FRIDAY, MAY 3, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 6th, 8 p.m. (Howard Lecture.) CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." (Lecture II.)

TUESDAY, MAY 7th, 4.30 p.m. (Colonial Section.) ALAN BURGOYNE, M.P., "Colonial Vine Culture." THE RIGHT HON. SIR WALTER HELY-HUTCHINSON, G.C.M.G., late Governor of Cape Colony, will preside.

WEDNESDAY, MAY 8th, 8 p.m. (Ordinary Meeting.) E. D. MOREL, "British Rule in Nigeria." SIR EDOUARD PERCY C. GIROUARD, R.E., K.C.M.G., D.S.O., Governor of Northern Nigeria (1908–9), and of the East African Protectorate (1909–12), will preside.

Further details of the Society's meetings will be found at the end of this number.

HOWARD LECTURE.

On Monday evening, April 29th, CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., delivered the first lecture of his course on "Heavy Oil Engines."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

Wednesday, May 1st, 1912; CHARLES HERCULES READ, LL.D., President of the Society of Antiquaries, and Keeper of the Department of British and Mediæval Antiquities and Ethnography at the British Museum, in the chair.

The following candidates were proposed for election as members of the Society:—

Dubash Kader Sahib, Khan Bahadur D.K., Abiraman-Natham, Ramnad District, Madras, South India.

Gordon, Duncan Macdonald, Keng Tung, Southern Shan States, Burma.

Harris, Thomas J., Botanic Station, Bermuda.

Morris, James, jun., Westdene, Ashburton-road, Birkenhead.

Neely, David Bradley, M.D., M.P., Humboldt, Saskatchewan, Canada.

Rutton, B. N., B.A., The Mall, Lahore, India.

Seabrook, Bagster Roads, P.O. Box 96, Toronto, Canada.

Seabrook, Norman Bagster, P.O. Box 96, Toronto, Canada.

Wakefield, William Birkbeck, Wilcot, Bisley, Surrey.

The following candidates were balloted for and duly elected members of the Society:—

Archer, Captain F., Main-road, Akyab, Burma.

Astley, Rev. Hugh John Dukinfield, M.A., Litt.D., The Vicarage, East Rudham, Norfolk.

Barnes, Charles A. Albert, Assoc.M.Inst.C.E., Government Survey Schools, Lagos, West Africa.

Eades, C. T., Beech-grove, Cheshom Bois, Bucks.

Jasonidy, Onuphrius John's, Blondel-street and Empress Ireni-street, Limassol, Cyprus.

Jones, Bassett, Jun., 1, Madison-avenue, New York City, U.S.A.

Laut, Miss Agnes C., Wassaic, Duchess County, New York, U.S.A.

Line, Charles Arthur, 39, Beaufort-road, Edgbaston, Birmingham.

Mackinney, Valentine Henry, Deancot, 85, Woodstock-avenue, Golder's Green, N.W.

O'Connor, H. J. Courtenay, Limehayes, Killyon-road, Larkhall-rise, S.W., and Bathurst, Gambia, West Africa.

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Robins, Herbert George, c/o Tanganyika Concessions, Ltd., Lulua Poste, via Elizabethville, Katanga, Belgian Congo.

Skrimshire, Alfred J., 31, Ryde Vale-road, Balham, S.W.

Weir, Charles James, Moorcroft, Silvermere, Cobham.

The paper read was—

ANCIENT EGYPTIAN CERAMICS.

By William Burton, M.A., F.C.S.

This is essentially an age of discovery, but it is likewise an age for the revision of past theories. Such a statement is particularly true of our knowledge of ancient pottery; for while, on the one hand, we find the archæologist studying every modern craft in order to obtain hints as to ancient methods, on the other hand we have many modern craftsmen keen enough about the development of their own craft who are able to throw light on the work of their fellows in remote antiquity. As such a craftsman, therefore, and not as an Egyptologist who finds valuable material in the commonest potsherds for his reconstruction of an ancient civilisation, I venture to address you.

It seems to me that too much has been made of the unglazed Egyptian pottery of every period. The ordinary red, buff, or brown pottery — evidently manufactured for the simpler domestic uses, and largely for the common people—has little to say for itself from the potter's point of view, however valuable it may be as material for sequence-dating to the student of history. It presents no essential difference, either in material or manufacture, from other forms of primitive pottery, whether of ancient or modern times. Its shapes, though characteristic, can hardly be called distinguished, and they have exercised comparatively little influence on the subsequent development of the potter's art in other countries. Compared with the early pottery of other great races, like the Greeks, Persians, or Chinese, the origin of which is almost as remote, the ordinary unglazed Egyptian pottery occupies a very secondary position. The only exception I should make to this statement is the red ware with shining black mouths, belonging to pre-dynastic times. It is quite otherwise, however, when we consider its ancient glazed wares dating from early dynastic or pre-dynastic times, with their brilliant turquoise colours of green or blue shade—colours which, if not unrivalled, have at all events remained unsurpassed through all the centuries. European scholars during the past century or so have described this glazed ware as "Egyptian Porcelain" or as "Glazed Faience." The reason for this terminology is not far to seek, in fact it is crystallised in Brogniart s famous "Traité des Arts Céramiques," to which the antiquary of our day generally refers with as much confidence as if it had been published yesterday. Honouring Brogniart, as we do, as the pioneer who first tried to reduce all that had been done in pottery to a system, it is only fair to point out that the foundation of a knowledge of pottery which may reasonably be called scientific, has arisen since Brogniart died. To-day we may say safely that the basal material of pottery of any kind is one of the natural clays, and that we cannot conceive the existence of a kind of pottery which does not contain some form of clay as an essential ingredient. If, however, it can be proved that the brilliantly glazed wares of the Egyptians did not contain clay as an essential ingredient of their substance, we must abandon the use of the names "porcelain" or "faience," that have hitherto been used to describe them. But how are we to settle, at this distant date, the nature of the material from which these beautiful objects were fashioned? In the first place we have, of course, the aid of chemical analysis, and the following table presents the most reliable analyses of the body of this Egyptian glazed ware that I have been able to obtain from objects of the various periods :—

	1.	2.	3.
Silica	94·00	94·18	94·18
Alumina . . .	1·80	0·59	1·93
Oxide of Iron . .	0·89	1·64	0·28
Lime	2·00	1·73	1·60
Magnesia . . .	1·05	1·82	0·05
Alkalis	0·25	—	1·11
Loss on ignition .	0·11	0·04	1·00

It will be seen that these analyses, in spite of minor variations, are remarkably constant in

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their main constituent, *viz.*, silica, and the first question we have to ask ourselves is how such a material could have been obtained by a mixture of natural substances. But to Brogniart and his contemporaries who, as it appears to me, were handicapped by the idea that the material *must* be a form of pottery, the figures given by chemical analysis could only be explained on the supposition that a large proportion of sand had been mixed with a very small proportion of clay to make the substance in question, and no one seems to have inquired whether such a mixture would possess the necessary plasticity to enable it to be fashioned by the general methods of the potter. After having tried many mixtures of the kind indicated by these analyses, I have been forced to the conclusion that the small amount of clay indicated by the percentage of alumina found would be entirely insufficient to give a material that could be shaped by pottery methods, and we have, therefore, to search for some other explanation of the general composition of the material used by the ancient Egyptians. It has been recognised for some time that the analyses given above would correspond roughly with the analyses of many ordinary sandstone and quartzite rocks, and my researches have satisfied me that the ancient Egyptians used some natural sandstone from which they carved the objects that have been so freely found in the tombs glazed with these brilliant glazes. It may perhaps be interesting if I indicate how this view has gradually arisen in my mind, because that may serve as another instance of the reluctance with which most of us depart from generally accepted views. When I first commenced to study pottery, the art of the ancient Egyptians was quite remote from my path, and I therefore accepted the views that I found put forward in the most authoritative books, and assumed, without question, that the glazed objects could be made by mixing a very little clay with a large percentage of sand. Like other students, I did not appreciate the fact that the earliest glazed objects recovered from Egyptian tombs comprise small scarabs, beads, necklace pendants, and such like things, carved in schist, steatite, and even in harder minerals, like rock crystal. In that fact there was a hint which ought to have led past observers to a sound view of this question long ago. The generally accepted view among Egyptologists to-day is that the blue or green glazes first appeared on objects carved from natural stones, and, remembering the conservative nature of the early Egyptian people, it seems to me natural that some soft sandstone should have been finally settled upon as the material particularly adapted to these especial glazes. I may be reminded that large tiles, glazed all over, were used to line the walls of tombs in early dynastic times, but I must point out that the carving of flat tiles from natural sandstone, and the application of turquoise glazes to them, is an art that has persisted to modern times. We find, for instance, that many of the tiles used for decorating the mosques and tombs in India and Central Asia, long after the ancient Egyptian civilisation had expired, were simply slabs of carved sandstone, and this craft represents the survival of a technical method used by the Egyptians as early as the First Dynasty. A consideration of the forms used in the early objects of turquoise glaze, whether green or blue, that have been recovered from tombs, will support the view that they were carved from some form of natural stone, and not, as most authorities have stated, thrown on the potter's wheel.

[Here a number of slides were shown of objects from the XIIth Dynasty down to Roman times, in which the technique was that of carving in fairly soft material, and not characteristic of objects shaped from plastic clay.]

In addition to the evidence of chemical analysis, and of technical methods of carving, we have a more complete and satisfactory test available. We may, for instance, treat these Egyptian glazed figures as a petrologist would treat an unknown rock to determine its structure and the nature of its constituents, and as I have from time to time obtained specimens of such material, which can be dated with reasonable accuracy, I have had prepared a number of thin slices which can be examined by all the well-known methods of microscopic examination with polarized light, etc., and the evidence furnished completely confirms the view that the Egyptians must have used a kind of sandstone, or quartzite, for their glazed objects, and not a substance containing any appreciable amount of clay. Of course, the number of specimens that I have been able to sacrifice in this way to scientific research is not very great, but in all the specimens I have examined, from the time of the XVIIIth Dynasty down to that of the Roman occupation, I find the general use of some natural siliceous rock.

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Fig. 1 is a section of an Egyptian glazed figure of the XVIIIth Dynasty viewed under crossed nicols, as one would examine a rock section, and its optical properties are at

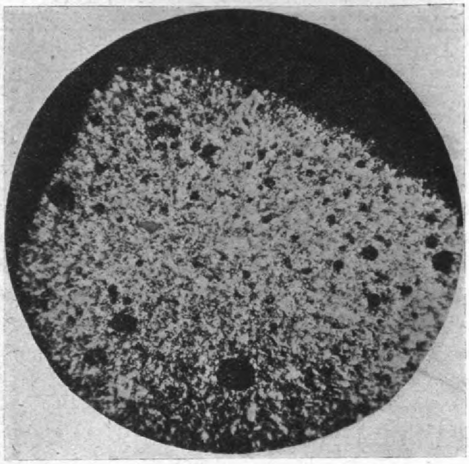

FIG. 1.—SECTION OF USHABTI FIGURE, XVIIITH DYNASTY. CROSSED NICOLS.

once seen to be eminently characteristic. The material consists of fine, sharp grains of quartz mixed with a few opaque particles of magnetic oxide of iron, but with no trace of any clay substance. Similar sections from a figure dating from the XXVth or XXVIth Dynasty, and from a little figure of the god Bes, which is probably as late as Roman times, reveal a similar structure, so that this series proves the existence of an unaltered technique, at all events for objects of certain kinds, for a period of at least 1500 years, at the very time when change was more rife in Egyptian methods than in the previous 2000 years. A comparison of such preparations with others made from typical objects of porcelain or pottery shows the profound difference made in the material by the introduction of a considerable proportion of clay.

Fig. 2 represents a slice of Chinese porcelain cut from a specimen sent to me some years ago by the late Dr. Bushell as an authentic fragment of Sung porcelain, as he had himself disinterred it from the rubbish mounds that mark the site of the ruins of the ancient Pekin destroyed by Kublai Khan in the thirteenth century. The difference between this material and the ancient Egyptian is strongly marked. Instead of finding the whole substance a mass of crystalline grains that can be readily identified by means of their reaction with polarized light, we have a granular amorphous material which does not react with polarized light, and scattered through this a number of crystalline specks which we can identify as the remains of the quartz and felspar crystals that were mixed with the china clay to form the body of the porcelain, and have not been entirely combined with it.

Fig. 3 is a section of a typical modern earthenware—an ordinary tile manufactured by my firm and taken casually from stock—and it exhibits a structure quite analogous to porcelain; except that, as we might expect, the modern mechanical methods used in preparing the ingredients of our pottery have produced a finer and more homogeneous substance than the ancient porcelain.[1]

This new evidence, which so conclusively supports the views already advanced, warrants us therefore in definitely separating the ancient Egyptian material from pottery, and I venture to propose that it ought to be described as "Glazed Siliceous Ware," for such a title would include all the objects carved from natural stones whether they be schist, steatite, diorite, rock crystal, or sandstone.

A further point of great interest is clearly established by the microscopic examination of these thin slices. Many observers have already pointed out that the ancient Egyptian material owed its strength to the glaze and not to the

FIG. 2.—SECTION OF SUNG PORCELAIN. UNDER CROSSED NICOLS.

body. In fact where such objects have been buried in situations where the glaze has been decomposed, the body became a soft and friable mass that could, as a rule, be readily powdered

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between the fingers, a state of affairs that does not take place with pottery. When slices of pottery and porcelain are examined microscopically, the glaze is always found as a

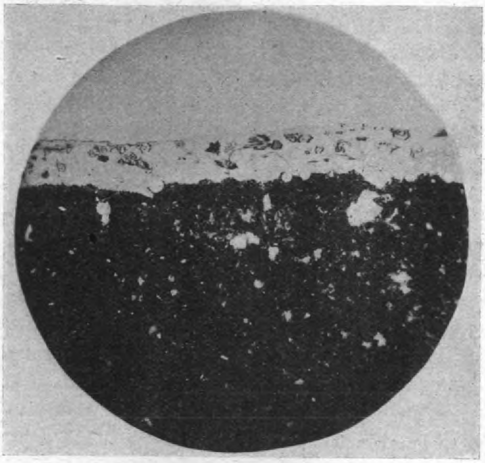

FIG. 3.—SECTION OF EARTHENWARE WITH CRYSTALLINE GLAZE. UNDER CROSSED NICOLS.

definite coating of glass of appreciable thickness, resting on the body material. We may return to our sections of Chinese porcelain and of English earthenware, Fig. 4 and Fig. 5, and, if we examine them under ordinary light, the glaze layer is readily distinguished from the close-grained amorphous body, which is, of course, much more opaque than the glaze. Fig. 6 represents a specimen of the Egyptian ware, and the difference is at once striking and characteristic. The glaze does not form a definite glassy layer resting on the body, but is seen to have sunk in or eaten its way in between the grains of quartz, so that we obtain a hard skin, in which the body grains can be clearly distinguished embedded in and partly dissolved by the glaze. As the glaze is strongly coloured it looks dark against the mass of the body—the very reverse of what we find with the glazes of pottery and porcelain. This action between the glaze and the crystalline grains of the body also enables us to explain a fact frequently commented on, that where hard minerals, like rock-crystal or diorite, have been glazed and the glaze has been worn off, the mineral is always found to present a pitted surface, showing where it has been attacked and partly dissolved by the glaze.

As to the nature of these earliest glazes, they are always found to consist essentially of silicates of the alkalies and lime coloured with oxide of copper—differing therefore from ordinary pottery glazes in containing no appreciable amount of alumina or of oxide of lead. Such glazes will only melt to a decent surface on materials very rich in silica, and any attempt to apply them to the surface of ordinary pottery fails disastrously, for on such a surface they yield only an irregular, puckered, mass.

Professor Eliott Smith, in his masterly little sketch, "The Ancient Egyptians," claims that one of the glories of the Nilotic peoples was their early discovery and use of metallic copper. He suggests that the first metallic copper may have been accidentally produced by some Egyptian woman dropping her earring of malachite into a charcoal fire. I would remind you of the passionate admiration shown by the ancient Egyptians for the beautiful blue and green stones, lapis-lazuli, turquoise, and malachite. All these stones were so highly prized as gem stones that we cannot wonder that any accident should have set the minds of these ingenious people at work towards their imitation at a very remote date, and it is at all events significant that the first coloured glaze or enamel that made its appearance, so far as we know, in the world is this wonderful blue or green turquoise glaze which owes its colour to copper, and to copper only. This art of glazing or enamelling on stone appears to me

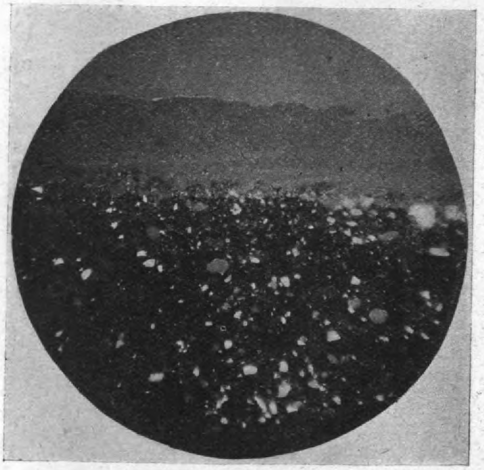

FIG. 4.—SECTION OF SUNG PORCELAIN. ORDINARY LIGHT.

to have arisen as a branch of the art of the jeweller and goldsmith, and not of the art of the potter, for the objects fabricated, down to the end of the XIIth Dynasty at all events,

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were for the most part small in size, and adapted only for use as jewellery, as personal adornment, or as adjuncts to the toilette. They consist almost exclusively of beads,

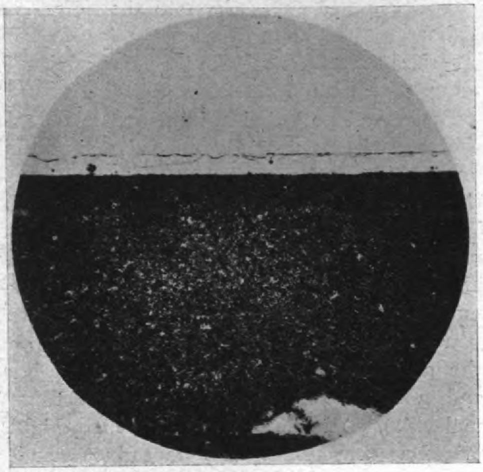

FIG. 5.—SECTION OF MODERN EARTHENWARE. ORDINARY LIGHT.

scarabs, rings, seals, badges, pectoral plates, etc., all having a close affinity in style to contemporary goldwork or jewellery, and presenting no resemblance to the contemporary work of the potter in common clay. Even when vase forms appear they are of small size (the Tuneh cups, etc.), and their shapes and outlines are derived, as I have said, from those common in carved stone, while they have no resemblance to the contemporary shapes of ordinary pottery. If my theory be correct then we reach another important point, viz., that the discovery of this art of enamelling on objects carved in various stones, including sandstone, did not follow the discovery of the art of making glass, but was really the *fons et origo* of glass, of enamelling on metal, and of pottery glaze. This view is supported by the nature of the earliest objects of *cloisonné* work, in which beautiful coloured stones such as lapis-lazuli, green felspar and carnelian were freely used many centuries before the use of coloured glass pastes. The real order in which the different fusible artificial silicates made their appearance at all events in Egypt (though probably not in other countries) appears to be, (1) blue or green turquoise glaze on stone objects, (2) glass paste, (3) glass wares made in the Egyptian fashion (not by blowing).

We have still to account, however, for the successive steps by which glazes of analogous composition were ultimately used on pottery vessels made from clay, by interposing between the clay and the glaze a thin layer of slip exceedingly rich in silica. For the present the evidence on this head is far from definite or complete. In late Roman times, and immediately on the Arab occupation, we find an extensive manufacture of Egyptian pottery made in this way, but we are in doubt as to when the practice originated, and whether on its first appearance this method supplanted the older method or whether, as seems to me more probable, the two methods went on side by side for some centuries, the earlier method being used for small traditional objects, especially those connected with religious rites and ceremonies, and the newer method gradually making its way by the development of larger and more ambitious vase forms. In this connection we have the fact that the Persian potters, contemporary with the close of the Egyptian dynasties, manufactured both tiles and vases coated with a sandy face and glazed with blue and green glazes analogous to the Egyptian ones. It may be that they acquired this knowledge from their occupation of Egypt during the time of Cambyses and his successors, though this is hardly more than a probable guess, and until a large series of dated objects has been examined by the means described in this paper we shall be unable to form any very definite conclusion as to the date of the new method which bridged

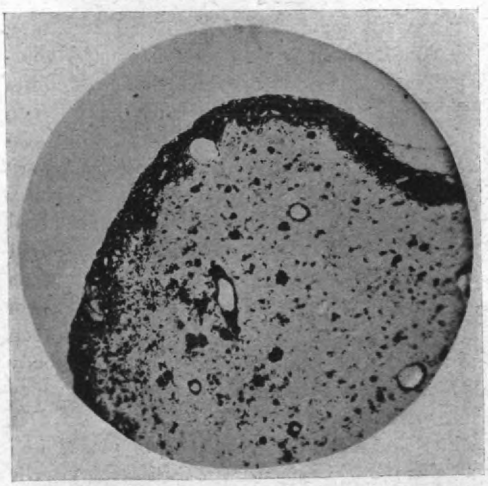

FIG. 6.—SECTION OF FIGURE OF GOD BES. ROMAN PERIOD. ORDINARY LIGHT.

over the gap between the "glazed siliceous wares" and Egyptian glazed pottery. Since the highly siliceous character of the early glazed wares has been more clearly recognised

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by Egyptologists, and it was realised that some alternative must be found for the belief in a mixture of sand with a small percentage of clay to give it plasticity, the suggestion has been made that the objects I believe to have been carved in sandstone were really modelled in sand, held together, and made sufficiently workable to be moulded, by the addition of some fatty or mucilaginous material. Such organic substances would be destroyed and disappear in the early stages of the firing, and then, of course, the glaze would hold the grains of sand together in the way already shown. This method may have been used for making the wares of the XXVth and later Dynasties, in which the whole composition appears to be a mixture of sand and glaze, but it can hardly have been in general use with sand alone, for though I have with considerable difficulty succeeded in making a few small glazed figures by this method, they are softer and more rotten in body than any Egyptian glazed objects I have ever handled.

In closing this account of ancient technical methods, which can only be regarded as tentative and suggestive pending the examination of a much greater number of dated specimens, I must mention one of the later technical developments which is of great interest. All Egyptologists are familiar with the incised ushabti figures of the XXVIth Dynasty just referred to, which are found in such amazing quantities in the tombs of that epoch. These ushabtis are denser and harder in substance than those of previous dynasties, they possess very little gloss, and are of a pale greenish-blue colour, which is found to be fairly uniform throughout the mass. There can be no doubt that these were made in moulds, the lines being sharpened up by hand if necessary, and it is perfectly clear that the composition, a mixture of sand and the turquoise frit or glaze, was uniform throughout, that there was no final coating of glaze applied to the surface, and further that such wares were fired to a higher temperature than that used for the ordinary glazed objects. French writers have not hesitated to describe this material as "porcelain," citing the fact that the earliest French porcelains of the seventeenth and eighteenth centuries, and the Florentine porcelain of the late sixteenth century, were made by mixing a large proportion of glass with the other ingredients. If such a material as that of these XXVIth Dynasty ushabtis is to be spoken of as porcelain, then we should have to acclaim these Egyptians as the first makers of porcelain in the world, for Chinese porcelain—the true porcelain *par excellence*—did not make its appearance for many centuries later. But the basal argument of this paper is that no substance can be rightly described as porcelain or pottery unless clay is an essential ingredient. These ushabtis do not contain any clay, and therefore I should not describe them as porcelain, but as "fritted siliceous ware," in contradistinction to the "glazed siliceous wares" of other days.

The most astonishing use of glass or glaze in the body of pottery is probably later still in date, apparently of Ptolemaic or Roman times, for a few small bowls have been found, glazed with the more glassy and transparent blue glaze of the late period, which are strongly marbled, as if made in imitation of a dark-blue veined onyx. When such pieces are held up to the light it is found that the marbling is produced by the introduction of fragments of a deep-coloured turquoise glaze in the material, so that the sides of the bowl appear set with blue windows.

I have chosen to speak only of the turquoise glazes because they are the most characteristic, and are the only ones that occur in every period, from the earliest to the latest. The white and polychrome glazes that began to make their appearance under the XVIIIth Dynasty, and were so largely developed in Roman times, must form the subject of a separate study.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, observed that he had never heard a theory so thoroughly revolutionary as that put forward by Mr. Burton presented in a calmer or more convincing way. It was, perhaps, less than justice to call it revolutionary, for it was difficult to say what would be the precise effect of Mr. Burton's discovery—for such it was—upon the technology of the ancient Egyptians. He (the speaker) thought scant justice had been done by Mr. Burton to the primitive races who had not already arrived at the refinement of adding glazes to their wares. He could show Mr. Burton, at the British Museum, a certain number of examples of unglazed wares which would command that gentleman's respect. Some of these were ancient British, some were from Spain, and of the Bronze Age; others were from ancient Mexico. All these had artistic qualities of shape and surface, and, as a potter of taste and experience, would command Mr. Burton's admiration. Mr. Burton

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had indicated the difficulties confronting his theory, and had recited the well-known fact that the ancient Egyptians were in the habit of glazing stone. A point which Mr. Burton had not, to the speaker's mind, enlarged upon sufficiently was that, up to now, no one had been able to discover, according to any method known to potters to-day, how these so-called pottery figures and vessels could have been made. It was an astonishing thing that, being familiar with these things, Mr. Burton, and others dealing with archæological subjects, had not long ago gone a little further by analogy. The speaker, having realised the astounding nature of Mr. Burton's theory, had gathered a certain number of fragments of various dynasties—the XXIst and XXVIth, etc.—and had broken little bits up and put them under the microscope. He had found one piece of the XXIst Dynasty to correspond precisely with that which had been shown by Mr. Burton in the first slide exhibited. He had then got two or three pieces of mediæval Persian ware made in a way that had always been somewhat of a mystery. These pieces possessed this quality, that the glaze appeared to be the strongest part of the fabric, while the interior or body seemed to be nothing but sand. One of the fragments, a very beautiful specimen of about the thirteenth century, was placed under the microscope. In common with some of the pieces that had been shown on the screen, it had a dark turquoise glaze. Further, it had precisely the same features as were presented by the pottery of the XXIInd Dynasty, of which Mr. Burton had spoken. By the aid of the microscope, without polarised light, the quality of the body was identical with the ushabti figure of the XXIst Egyptian Dynasty, resembling the broken surface of a sugar-loaf. The bowl was so thin that it was inconceivable that it could have been carved in the way Mr. Burton had put forward as the process by which the ancient Egyptian figures were made. He would not attempt to explain the significance of that, nor would he pit his observation against the technical and chemical knowledge of Mr. Burton, but he would ask that gentleman to take an early opportunity of examining the piece himself. With regard to Mr. Burton's proof of his theory by dealing with a large quantity of material, the speaker was certain that every person interested in ceramics generally, or in Egyptian archæology, would be prepared to supply him with twenty times as much material as he could deal with. Mr. Burton's discovery would alter the technology sequence, so to speak, of Egypt, and he had pointed out, notably by the relations of the various objects to which he alluded, in what way that alteration would take place. The speaker disagreed with Mr. Burton's reference to enamelling on metal. He (Mr. Read) did not believe the practice existed in Egypt at all; at any rate he did not know of any examples. Inlaid glass or stones like *cloisonné* enamel were commonly found, but these were cut out cold and inlaid in divisions, whereas the essence of enamelling was that it should be fused in place. Mr. Read agreed with the lecturer as to the definition of porcelain; the laxity with which that word was used was a matter of difficulty, not only with Englishmen, but foreigners. Porcelain was as definite a thing as, say, rock crystal; yet people described as porcelain substances which, as Mr. Burton had shown, were sandstone. Such people would, however, regard as wild the description of a piece of rock crystal as glass, or the converse; yet the difference was not greater in one case than in the other.

Miss M. A. Murray pointed out that there were specimens of glass, such as Mr. Burton had spoken of, in the Ashmolean Museum at Oxford. There also were some glass beads, which were among the earliest specimens of their kind. She was not prepared to give an opinion on the revolutionary theory propounded by Mr. Burton, but, so far as she was aware, no vases or other objects of this glazed ware had been found which had fallen in the fire. None of these fallen pieces of glazed ware had been found in the Roman times in the kilns of Memphis. Whether that was an argument in favour of Mr. Burton's contention, she was not prepared to say. All the early glazed ware of which she had knowledge was small, with the exception of the great sceptre of blue glaze of the XVIIIth Dynasty, now in the South Kensington Museum, and standing something like five or six feet high. Glazed ware of the Roman times was, the speaker considered, pottery, as it had fallen in the fire. She would ask Mr. Burton whether he regarded the small glazed beads found in such numbers in Egypt as pottery or sandstone.

Professor J. M. Thomson, F.R.S., discussed the paper neither as potter nor Egyptologist, but as a chemist. Judging the author's theory from the standpoint of the analyses, it had strong support, as they certainly represented the composition of sandstone or some analogous mineral, not clay or pottery ware. There was also the strong evidence of the microscopic sections, which were perfectly distinct and different from pottery. From a chemical point of view, therefore, Mr. Burton had good reasons for his theory. The speaker's investigations related more to the colours in the glazes, and he was much interested in the author's remarks on them, especially about the early blue. He understood Mr. Burton to say the blue was copper. The greens, even the early greens, were known to be copper, and he was much interested in hearing of the approximate date of the early copper blue. He would ask the author if he knew the earliest date at which cobalt was found as a blue in such pieces. He would be glad also to learn whether, in any of the vessels microscopically examined by the author, there were three layers—the substratum, the siliceous matter, and the

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glazes. He (the speaker) had had occasion to examine some Persian tiles for colours. He had noticed what appeared to be three different layers.

MR. NOEL HEATON said that, although he was something of an archæologist, he was not an archæologist of Egypt. He had, however, recently had the privilege of studying an adjacent civilisation in the island of Crete, which offered some points of support to Mr. Burton's theory. For himself he unreservedly accepted this theory. In this adjacent country of Crete most magnificent carvings in steatite were found. That was the next step. Many people would doubtless regard such carvings with wonder, and would dwell upon the difficulty of carving elaborate forms like these in natural stone. As Mr. Burton had pointed out, it was not necessarily always sandstone; other forms of schist and steatite were used. The country was in constant intercourse with Egypt at the time when these beautiful carvings were being made, not alone in steatite, but in harder stones. He did not know whether there were any actual examples of glazed steatite. A number of objects were also found which, without inquiry, had been taken to be glazed faience. He would like to suggest to the author that he should examine some of these. There were, at about the XVIIIth Dynasty a number of extraordinarily beautiful glazed objects, such as little statuettes of human figures, and it would be interesting to see if these turned out not to be pottery at all. The speaker had seen a lump of blue frit, from which the glaze was prepared; it was a mass cut out in the form of a vase. He did not consider any chemist, or anyone familiar with the fundamental technology of pottery, would deny that a substance containing 94 per cent. of silica and barely 2 per cent. of alumina could not be pottery. He could sympathise with the Chairman's difficulty in regard to the proper use of the term "porcelain." He had met similar trouble in the use of such words even as "fresco" and "glaze," and he had had some correspondence with the author on the use of the word "glaze" in connection with Attic pottery. Mr. Burton called it a "bituminous material." It was the same the world over; the builder and the geologist were in disagreement about the word "marble," for instance. With regard to enamelling, he had examined collections from time to time, but could not remember having seen anything which could be described as enamelled metal, and he did not quite see how, at such an early period, enamelled metal would have been possible, considering the nature of the glaze used.

MR. WALTER C. HANCOCK said that Mr. Burton's theory furnished an excellent example of the way in which the obvious was missed for centuries together. The analyses the author had shown were plainly of sandstone. Doubtless Mr. Burton was aware of the work of Professor Henri Le Chatelier, carried out five or six years ago, on certain so-called Egyptian pieces. The results of this work were identical with the analyses shown by the author. From the purely ceramic point of view, these pieces were not pottery. There was no doubt that the proportion of clay (if any) was infinitesimal, and would have absolutely no effect on the plastic properties of the mass. He had been interested in Mr. Burton's references to the use of colloidal and mucilaginous substances, especially as the point had been frequently raised of late years. From the few experiments made, he did not think it materially increased the "working" properties of the mass. With regard to Mr. Burton's theory, he did not think any very poignant criticism had been brought against it. The author had shown conclusively the alteration which took place in the body due to firing—the formation of solid solutions. It might be said that if the examples were of carved sandstone or schistous material, they might not have been fired at a temperature sufficient to bring about the changes of the body which would have been brought about in the case of ordinary porcelain. In attempting to reconstruct the technological processes of ancient times a great deal of evidence was derived from the surroundings in which the various articles were found—kilns and so forth—and it was of interest to know whether any tools which were at all likely to have been used in carving the schistose or quartzite materials had ever been found in conjunction with the carved materials. In conclusion, he had no doubt of the correctness of Mr. Burton's theory from a chemical point of view.

MR. E. E. PITHER inquired whether any other colours than blue and green had been found in this ancient ware. He had secured some time ago a piece which had a red colour, and a sort of lustre.

[Mr. Burton here stated that many colours were used, and during the period of the Roman occupation there was a great deal of polychrome ware.]

MR. WILLIAM BURTON, in reply, said that his object in reading the paper was to present the results of his studies, and show the direction in which they had been leading him for some years past. He was much interested in the Chairman's reference to the specimen of Persian ware of the twelfth and thirteenth century. The technique of carving in stone and glazing with glazes analogous to the earliest Egyptian had never ceased, but had travelled from Persia into the centre of Asia, and so into India and China. The Chairman had in his possession a fragment from the centre of Asia, and there were hundreds of such fragments. With regard to the expression "enamelling on metal," he could only assume that he had carelessly copied the phrase from the writings of some Egyptologist; he realised perfectly well

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that enamelling on metal was not done. His object was to refer to the first use of a substance that could be called "glaze," which he would suggest, arose incidentally from the fusion of some malachite with other substances. The Egyptians undoubtedly glazed with glazes of that type, consisting of nothing but silicates of the alkalis and lime, coloured with oxide of copper, and that technique went on for certainly 2000 years. Then followed the production of glass paste, but not made in such a way that it could be blown, as the Roman and Phœnician glass could be. The Egyptians did not appear to have blown glass until a late period. Their manufacture of glass vessels arose from their first making glass paste. What was revolutionary in his remarks was this, that people had always assumed that the glaze of pottery was a glass, and that therefore the discovery of glass must have preceded the discovery of the glazing of pottery. He believed that the Egyptian glaze was the first discovery, and that glass itself followed a considerable time afterwards. He was grateful to Miss Murray for her suggestion that glass made its appearance as early as the First Dynasty. He could only say that there were different understandings of what was glass. He had seen the glass bead of Mena, of the First Dynasty, and had suspended his judgment as to whether it was glass. Replying to Miss Murray, with reference to the great quantities of beads, he was not prepared to say that none of the beads were of pottery, but in his opinion the early beads were made out of the glazing stuff itself. Miss Murray was right in her conjecture that in Roman times the glazed ware was pottery, because the pieces had been found sunk out of shape in the kiln, which again supported the speaker's theory. In the early dynasties none of these pieces were found which had gone out of shape in the fire. One difficulty arose on which he was unprepared with a suggestion. When did the transition take place between the application of glazes to objects carved only in stone and to objects fashioned in pottery clay and coated with siliceous coating? He believed that it began as early as the XVIIIth Dynasty. In reply to Professor Thomson, he would say that he had found so many mistakes in analyses, especially old analyses, that he preferred to make his own. He was aware of Le Chatelier's analyses, and would accept them. The blunders made by some of the older analysts showed how careful it was necessary to be in using other people's work. Professor Thomson had pointed out that in some old Persian stone he had found three layers. That was the old Persian technique referred to in the paper, where the body was shaped in a kind of clay which was fairly siliceous, then coated with a thin coating of a clay mixture very rich in silica, the glaze finally coming on the top. In making enamels on metal, the enamel might not attack the metal, but might simply melt and remain there. The melting of any form of glaze or glass on a piece of clay would be equivalent to melting mixtures of silicates of low fusibility on other mixtures of silicates of higher fusibility, and interaction was bound to take place between them. He had been the first to point out that there must be a kind of buffer layer between the glaze proper and the body proper, the body becoming gradually more body and less glaze in one direction, and more glaze and less body in the other. It was difficult to make people understand that while a pottery glaze was a glass, it was one of very special character. In relation to colour, there was no doubt that all the blues and greens of the oldest glazes were derived from copper only. For nearly five thousand years copper had been used as the colouring element, before there was any trace of cobalt having been used. The colours could all be made out of the same mixture, it being wholly a question of the temperature of the state of aggregation of the silicates; that was to say, how far the firing was pushed. Take a certain piece of Persian or of old Egyptian blue fired up to 1000° C. At 100° hotter than originally fired, it of course became green, and the more it was fired the greener it became.

The Chairman, in moving a hearty vote of thanks to the author, said that the deduction from Mr. Burton's analyses could only be in one direction, namely, that the material analysed could not be pottery or plastic material at all. This was contrary to the belief of archæologists and Egyptologists, and it was, to use an Americanism, "up to them" to show how the material was made if not made in the way Mr. Burton had suggested. On the question of glass derived from glazes, as Mr. Burton had said, there was *glass* and *glass*, and the glass paste referred to by Miss Murray probably would not make a blown glass vessel at all. There was the glass paste used for inlaying in exactly the same way as stones were cut. A similar material was modelled round a clay core, and the core withdrawn, the result being a glass bottle. It was necessary to be careful, in speaking of glass, to know precisely what was understood by the term.

The vote of thanks was carried unanimously, and the meeting terminated.

SHIPPING AND NAVIGATION OF PORT OF ANTWERP.

Sir Cecil Hertslet's annual report on Antwerp always contains interesting matter from a commercial and shipping point of view, and one of the principal features in that for 1911 is the very large increase in the port returns, which is indicative of great prosperity in the trade of Belgium. Sir Cecil remarks that this is largely due to the popularity of the port, which continues to attract traffic, notwithstanding the great efforts made by its powerful

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competitors to outstrip Antwerp in proffering advantages to the trade. At present the accommodation of the port is barely large enough for the immense volume of shipping frequenting it, and much delay has occurred in the completion of the new docks which have been in hand so long. The new entrance giving access to the existing basins is also urgently required, but unfortunately appears no nearer a commencement than it was last year.

During the whole of 1911 freights have been hardening, and at the time of writing the report the situation in the freight market was quite brilliant, the quotations being good for practically every part of the world, a feature very rarely observable elsewhere.

In respect of tonnage of vessels, the returns for 1910 constituted a record, but notwithstanding that, and a strike of seamen, the figures for 1911 displayed an increase of 5½ per cent. over those of the previous year. A predominating position is still happily maintained by British shipping, which in respect of tonnage was 48 per cent. of the total for all countries. Germany is of course Great Britain's chief competitor, and the two together dominate the port.

The inland navigation of Antwerp is of a peculiar character, being carried on for a great part in large barges which are either towed or self-propelling. The trade may be compared with the coasting trade of London, with, however, this important difference, that the latter consists of vessels plying between London and other ports in the United Kingdom, while the barge or inland traffic of Antwerp is more of an international character, coming and going by canals and navigable waterways from France and Germany, in addition to the inland traffic of the country proper.

The number of passengers carried on the Harwich-Antwerp service shows a falling-off for the year 1911 compared with that for 1910, when the Brussels Exhibition caused a special inflation of the returns.

THE FOREIGN TRADE OF ITALY IN 1910.

The recently issued report on the foreign trade of Italy for the year 1910 contains a good deal of information of interest to British commerce. The total value of the trade is the highest recorded since the establishment of Italian unity, the value of the exports having increased as much as 11 per cent., while the imports show an increase of 4 per cent., the latter being mainly attributable to the higher price in 1910 of raw cotton (imported chiefly from the United States and British India), as well as to a larger importation of cereals (from Russia and Roumania), and of indiarubber (from Brazil). In the matter of exports, Italy has made remarkable progress, an increase of about £3,000,000 being recorded under the heads of spirits, wines, and oils, and of over £1,400,000 in cotton goods. With the exception of the silk trade, there has been a rapid recovery in Italy from the world-wide depression of 1908. Notwithstanding the steady increase in the use of hydro-electric power, there has been no falling-off in the importation of coal, a circumstance tending to show that Italian factories are doing well.

The vintage for the year was very poor, the worst since 1905, and this caused a sharp rise in prices of wine, especially on the receipt of increased orders from abroad. Switzerland is Italy's best customer, but a good deal of wine is also sent to Brazil and the United States, and endeavours are being made to obtain a steady footing in the Austro-Hungarian market.

The oil crop was double that of the preceding year, and exports to the United Kingdom exceeded by nearly one-half those of 1909, though the United States, the Argentine Republic, and France are Italy's best customers. Under the class of hemp, flax, and jute, there was considerable increase in exports, and in respect of raw hemp and thread the United Kingdom figures conspicuously.

The year 1910 was a disastrous one for the important cotton industry. Two successive short crops in 1908 and 1909 had brought about a heavy rise in the price of the raw article, so that many factories had to reduce their establishments or shut down altogether. Imports of raw wool increased largely during 1910, while those of the finished articles continued to decrease. Italian manufacturers are trying to drive foreign woollen goods out of the home market, but purchasers who wish to have goods of the best quality still insist upon British or German woollen cloth, in spite of the higher price of the former. Silk, raw and manufactured, the most important among Italian industries, had during 1909 shown signs of recovery from the serious crisis of the two preceding years, but in 1910 exports fell back once more, the total value of all kinds showing a decrease of £1,314,692, as compared with those of the preceding year.

While the importation of boots and shoes has nearly trebled during the last three years, exports have fallen to about one-third of the figures for 1908, Italian factories, which for the most part make use of handwork, being no longer able to compete with foreign machine-made goods.

The output of the Italian iron mines, chiefly situated in the Island of Elba, amounted in 1910 to 551,259 tons, being an increase of 46,064 tons over the figures for the preceding year. The production of pig-iron amounted to 353,239 tons, as against 207,800 tons in 1909, all being consumed in the country, in addition to 205,975 tons imported from the United Kingdom and Hungary. The low price of steel in Italy has fostered the manufacture of rails, of which up to 1907 Italy had to import large consignments. Local production has now almost doubled, and imports have decreased in proportion, Belgium, Germany, the United States,

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and Great Britain, being the chief supplying countries in the order named.

In motor-cars there was a slight decrease, both in exports and imports. Italy's best customer is the United Kingdom, which during 1910 purchased no less than 813 cars out of a total of 2,120 exported.

Comparing the values of the trade with different countries, it is noteworthy that Germany still maintains the first place, both on the lists of imports and exports. As to the latter category, the United Kingdom has made great progress, and now ranks fifth among Italy's customers, the chief items showing increases being silk tissues, eggs, fruit and preserves, raw hemp, olive oil, etc. In regard to imports the United Kingdom is second in rank, but the values show a decrease as compared with 1909, owing to the fall in price of coal. There was a small increase in woollen stuffs, and in rubber goods the United Kingdom has made notable progress from £98,450 to £410,963. England has also more than doubled her exports of copper, brass and bronze wares to Italy, and is competing keenly with Germany in the supply of tools for working wood and metals.

THE MAHOGANY INDUSTRY OF HONDURAS.

One of the great sources of future wealth in Honduras will be found in the forests where mahogany grows, as there are thousands of acres where the timber is to be found in its primitive isolation. The fact that the mahogany forest, or even the mahogany grove, is non-existent makes for the high value of the wood. True, mahogany is the familiar dark coloured hard wood largely used for household furniture, supplied by a tree native in Mexico, Central America, Panama, Colombia, Venezuela and the Caribbean Sea. The tree sometimes grows to a height of one hundred feet, with a diameter measurement of twelve feet, Frequently trees are found that five men joining hands cannot circle. A decoction made from the bark was considered a remedy for fever, while the Aztecs used the seeds as one of the ingredients of a cosmetic. Its period of growth covers, perhaps, two hundred years, which fact, in connection with the limited area where mahogany is found, makes difficult the compilation of accurate data descriptive of the botanical history of the tree. According to a recent report by the International Union of American Republics, the principal false mahoganies are African or Senegal (the true tree grows in Nigeria), Australian (a eucalyptus), Ceylon mahogany, Indian (the toona tree in Bengal), Madeira mahogany (*Persea indica*, or canary wood), bastard mahogany, and in the United States, California and mountain mahogany. Nearly all real mahogany grows north of the equator in an area limited by the parallels 11° and 23° north latitude. Small areas in Panama, and recent sources of supply discovered in Africa, lie without this zone, but few trees of this species have as yet been found below the equator, which is curious in view of the fact that suitable climatic conditions exist in countries lying in corresponding latitudes south of the equatorial line. Logging for mahogany is carried on to-day in the same primitive manner that served in collecting the wood in early days. In the main it is the process used in the forests of the United States and Canada, with minor modifications because of special climatic conditions. Fortunately the trees are found near the coast. The trees are cut in the rainy season. A man climbs to the highest limbs that will afford him the best view of the forest. He marks down the mahogany by its conspicuous yellow-reddish leaves, then descends and leads the cutters through the jungle, hacking a road as they go, till the mahogany tree is found. Then saws and axes are applied, always at the time of the waning moon. The superstition that calls for the cutting of the trunk by the light of the waning moon is based on good botanical grounds, for experience has shown that the mahogany tree is freer from sap, sounder, and of a richer colour at that period. And the cool of the night offers the best time for the hard work, so the wisdom of the custom is apparent. The hauling of the fallen trunk to a stream is the work of oxen still, and must be done in the dry season when the ground is hard. Once in the stream, a raft is made, and floating is carried on just as in any logging country. At the ship's side the logs are immediately hoisted aboard to avoid the ravages of the boring toredo. London is the great mahogany market. It is well known that the wood is noted for its hardness, durability, beautiful colour and grain, and in the diversity of these qualities lies the value of the hewn trunk. There are two main differences in grain pattern, the close-grained mahogany, the best of which comes from Cuba and Jamaica, and the wide-grained, also known as baywood, the mahogany of Honduras.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Half-Time Question.—As Parliamentary debate of the half-time educational system has concerned itself with other points of view, it has necessarily left a few things unsaid which occur immediately to the textile manufacturer. Industrially, the affair is a textile one almost exclusively. Substantially, eight-ninths of the children of twelve to fourteen years of age who vary wage-earning with alternate half days of schooling do so in the heart of the textile region —*i.e.*, in Lancashire, Yorkshire, and Cheshire. No other industrial interest is affected in any comparable degree by the proposed overthrow of the arrangement. Cotton, worsted, flax, jute, and silk have each its cohort of half-timers, but these are not distributed equally over the industrial departments. The carded woollen trade has virtually none, and weaving and finishing find no

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employment for them worth mention. The half-timers work in the spinning-mills chiefly at setting-on and taking-off bobbins, removing loose fluff from spinning rollers, and tying neat knots in broken threads. They are employed because the work is well within their compass, because of economy, and also because of ulterior technical advantage. Economy alone may explain the employment of the larger number; not necessarily that two half-timers are cheaper than one full-timer, but that a difficulty exists in ensuring a sufficiency of young, and consequently cheap, labour for the mills. The half-timer is broken in gradually to mill work and the manipulation of machinery, and, in some departments more than others, gains an advantage from an early start which lasts for the whole of her mill life. There are painters whose sincerity it is impossible to doubt who maintain that no artist attains the maximum of proficiency who does not begin serious practice before the age of fifteen. Similarly, there are worsted spinning managers who aver as stoutly that—be half-time bad or good educationally—it is an arrangement indispensable to the production of the finest yarns. The girl who begins at eight makes a better spinner for life than one who begins at nine, and every successive year of delay leaves its mark upon her aptitude. This proficiency is of less account in making the coarser yarns, and here the increasing automatism of machinery promises to relieve the demand for young labour. That the ability to produce ultra-fine botany yarns is jeopardised, there is, unfortunately, no doubt.

Although in Parliament the half-time question has been spoken of as though it chiefly affected boys, there are, in point of fact, considerably more girls, and to them the employment is anything but a "blind-alley." The experience gained in the spinning-room is advantageous, whether time leads her into the winding or weaving departments subsequently or not. In the case of boys it cannot be agreed by those who know the industry that ejectment from their posts in one mill leaves them in the unfavourable plight of those who have been following less disciplined callings. Difficulty in getting juvenile labour enough is said to have resulted in the employment of more married women in the mills of one district, and the probability that more mothers will go out to work because their children are prevented from doing so is a point which should not be overlooked.

Technical Instruction.—At an early date textile tuition was advocated in this country as one arm of the poor law. John Bellers propounded in 1696 the scheme which Pitt warmly commended a century later. In Bellers' "colledge of all useful trades" were to be "2 linnen and 2 woollen weavers, 2 flax-dressors and thred makers, 2 spinners and carders for stockins and 20 linnen and 20 woollen spinners and carders," whose permanent function was to have been the instruction of the young in these crafts. The college was never founded, and the first forerunner of the excellent textile colleges of this day was apparently the school of cotton-spinning opened in 1810 at the Conservatory of Arts and Trades in Paris. In 1843 a M. Lambelet opened a weaving school in Verviers, the chief centre of the Belgian woollen trade, and these seem to take priority over English efforts. Perhaps the records of the Mechanics' Institutes of the mid-nineteenth century contain reference to organised classes, and to such places and to tradition concerning early "mutual" classes one must look for information. The present colleges, equipped with machinery capable of carrying on all operations, began humbly as classes for the teaching of designing and cloth structure. It was thus with the textile department of the Yorkshire College, Leeds, which was founded in 1874. Until 1880 there was no department of dyeing, and until 1900 no spinning department. The textile equipment of the University has now been rounded off by the munificence of the Clothworkers' Company, to which Leeds is indebted for £75,000 worth of land, buildings and plant, and an endowment of £4,000 a year. The latest extension permits of instruction in systems of spinning which are little used in this country, although employed extensively abroad. The policy of introducing machines not found in the mills of the district has been followed also at Bradford, and textile teaching in most quarters devotes itself increasingly to research and exact examination of the results obtained by use of different means.

Foreign Students at Textile Schools.—Visitors to any of the large textile schools note amongst the day students a heavy proportion of foreign youths. English policy towards them is more liberal than the German, which charges fees three to six times higher to strangers than to natives. English fees are the same to all comers, and the fact is not one that textile machinists need regret. In his after career the student is drawn strongly to prefer the type of machine on which he learned his business. The machine is bought for the purpose of producing abroad something like English cloth, but this is not an undiluted misfortune. The user needs materials similar to the English as well as English machinery, and this disposes him towards the yarns and raw materials that English firms have to sell. Traders to the Scandinavian countries, for example, have positive evidence that the users of German machinery there incline always to use German materials upon them, and probably it is for these that the machines are best fitted. Where the machinery is English, the tide of favour is steadily in the other direction.

Fireproofing Cotton Goods.—Coroners' inquests continue to lend zest to the pursuit of efficient means of flame-proofing cotton goods. The conditions of the problem are against the chances of rendering it absolutely fireproof, as it is indispensable to retain the general characteristics which make cotton an eligible article of wear. The treatment must be cheap, for it is for application to the cheapest of fabrics, and the resultant need

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not rival asbestos in indestructibility. It is necessary simply to render cotton as little inflammable as woollen or silk, in order amply to meet the requirement. Use of hygroscopic dressings is to be avoided, as pneumonia is as much an enemy as fire, and hygroscopic salts, being highly soluble, disappear promptly in washing. Irritant dressings are to be shunned, and this disqualifies for use zinc salts of recognised virtue against fire. Borax, common salt, alum, silicate of soda, sulphates and phosphates of sodium and ammonium and titanium salts are all recognised to have greater or less efficiency, and have all been used for the purpose. Tungstate of soda, made by fusing wolfram with soda ash, is the standard chemical for the purpose, and experimenters do not find the stannate of soda named in Dr. Perkin's patent to be an improvement on the cheaper salt. Flannelette treated with stannate of soda and ammonium sulphate has a large sale, and appears to retain much of its resistance after washing.

The World's Wool.—An Australian official estimate gives some 500 millions as the proximate number of the world's sheep. Some 600 millions are estimated by the United States census authorities, and not less than 700 millions is the total ventured by the statistician to a wealthy body of American manufacturers. The discrepancy is sufficiently glaring, considering that the figures relate to almost the same period. It is not, however, inconsistent with a remarkable unanimity as to the produce of wool. Despite the aberration of 200 million head, the authorities agree on an estimate of roughly 3,000 million lbs. of raw wool. The same total is suggested by the President of the French Customs Values Commission, and its probability is further supported by those received authorities, Messrs. Helmuth, Schwartze & Co., London, whose estimate of the raw wool produced in and imported into Europe and North America is 2,567 million lbs. This leaves some 400 millions to local consumers outside the chief manufacturing countries, and the item is not one about which it is necessary to trouble in practice. The volume may be accepted as real on the strength of the evidence, and, applying to it the mean value of 9*d.* per pound, a sum of £112½ millions remains as the probable value of the world's clip. Ninepence, it may be added, is the average value of the wool imported into this country in the decade 1900–09, and is below the price which has ruled since.

Messrs. Helmuth, Schwartze & Co. calculate that their 2,567 million pounds reduced to the clean state by washing shrinks to 1,412 millions, and for the present the supply per head of population is not decreasing. The population of the chief wool-consuming countries grows currently at the rate of six millions a year. In the period 1861–70 there was brought to the doors 2·26 lbs. of wool per head of the European and North American population, and on balance the amount has grown ever since, rising to 2·76 lbs. of clean wool in 1891–1900, but falling to 2·61 lbs. in the broken period 1901–06. Since 1907 the amount has increased 4 per cent., and is once more standing near the 2¾ lbs. limit. The allowance does not look excessive upon its face, and seems no more generous when regard is paid to the weight of one's personal clothing. A pair of blankets weighing eight pounds is not a heavy pair, and eighteen ounces the running yard is a normal weight for cloth to be used in suits. As a suit consumes 3¼ yards of cloth its weight may be taken at 3 lbs. 10 ozs.—or seriously more than a strictly equal division of wool would give, even were there no sinkage in manufacture.

NOTES ON BOOKS.

INDUSTRIAL EVOLUTION IN INDIA. By Alfred Chatterton. Published by *The Hindu* Office, Mount Road, Madras.

Those concerned with the passing wild anarchy in the fine and the applied arts of Europe, and who know Mr. Alfred Chatterton, whether personally or by his work in Madras, and how well equipped he is by his dispassionate natural temperament, and thorough scientific and professional training, and practical experience, to enter the lists in the controversy he so ably grapples with throughout this volume, will be the first, on opening it, to exclaim against its obtrusively defective titlepage. The book is made up of 369 crown octavo pages, of sound paper, carefully and clearly printed, and strongly bound together in glazed green cloth—with the matter of it all magisterial and of the widest interest—and yet its titlepage leaves the inquirer puzzled as to where to write for a copy of it. *The Hindu* is an Indian daily and weekly newspaper, having an office of issue in Mount Road, Madras; but it is printed by the Guardian Press, Blacker's Lane, and published by the National Press, Wallajah Road, while its address is "Post Box 82," Madras. This sort of carelessness is what makes it so difficult, even for persons like myself, to obtain books, published by native firms, direct from India, and almost impossible to do so through booksellers in England, who have repeatedly to reply to your applications, "address insufficient." The agent, or agents, for sale in England, should be named on the titlepage of every book produced in India, if meant for circulation in Europe and the Americas. Moreover, nothing of Mr. Alfred Chatterton's credentials are given on the titlepage; and he was not only Professor of Engineering under the University of Madras, and a Fellow of the University, and Member of its Faculty of Engineering, but had graduated before he went out to Madras as a B.Sc.

The outstanding note of the volume is the distinction drawn throughout it between the mechanical and the artistic industries of India, a distinction ever to be scrupulously and strenuously observed by all responsible for the welfare, alike moral and material, of the peoples of India, and

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especially of the Hindus. In the simple mechanical industries, the Hindus, like most of the Caucasian races of Asia, are notably deficient; and there is indefinite room for the development of them; and an urgent necessity for it in a country where the rapid growth of the populations, under the British Raj, is beginning to press so alarmingly on the means of their support. But in the artistic industries, regarded, not as an economic asset, but as a spiritual dower and glory, India stands at the head of the Aryan world of Asia and Europe, and the Americas; and we cannot interfere between them in any way, and certainly not through our Schools of Art, unless it be the more considerately to protect them in their traditional idiosyncrasies, without doing serious, nay, deadly detriment not only to the hereditary craftsmen of the country, but to the artistic genius, and the religious faith and character, of the whole sacrosanct races and nationalities of Brahmanical Hindus. It was not always so with Mr. Alfred Chatterton. Going out straight from England to Madras, he at once set about valorously manufacturing, on behalf of the Government of Madras, goblets [*lotas*], bowls and basins, all of aluminium [clay feigning to be silver], in substitution of goblets, bowls, and basins of clay, and brass and copper, etc.; in ignorance of the fact that not only the uses, and the forms, and the decorations, but the very materials of these vessels, as used by Hindus, were all sacramental. This is our stubborn British way; and the pity of it is that the ruck of us in India persist in it—and in every branch of our administration—to the very end of our several individual lives; and every single Englishman, Scotsman, and Irishman is in India a potent influence for good—or for evil. But Mr. Alfred Chatterton soon saw his error, and in his case no great harm came of it; while now, by the publication of this book, and in the Presidency town of Madras, great good will be done, and not only in Madras, but in every part of India where the questions he so admirably discusses in it are daily engaging an ever increasing attention.

Mr. Alfred Chatterton divides the book into twelve chapters; and in the first, second, and third, treats of the Indian Industrial Problem generally, including the question of "Protection" and "Tariff Reform" for India; in the fourth, of Agriculture; in the fifth and sixth, of Industrial Enterprises generally, and Expert Assistance in the same; in the seventh, of Chrome Tanning; in the eighth, of Hand-loom Weaving; in the ninth, of Miscellaneous Industries, such as Wood Distillation and Milk Products; in the tenth, of Well Irrigation; in the eleventh, of Engineering in India; while in the twelfth, and final, chapter, he reviews the attitude of the Government in relation to the Industrial Evolution of India. From first to last the volume never fails in interest; and every chapter opens up the prospect of unlimited employment during the next hundred years and more in these new scientific industries for the natives of India, or failing them, through their want of ambition and energy, for Europeans. The evolution is, so to say, self-developing, and must not be hustled and rushed, but be simply, and sedulously, and sympathetically, watched, and eased, and supported in its course, and with the divine long suffering of Nature that

"... from the mire,
In patient length of days,"

has elaborated the glory and the wonder in the highest of the whole Cosmos. Above all, we must never forget that the people of India still, in spite of all our European education, happily believe in the unknown powers of the universe. Some forty years ago, the wells having failed over a wide district in Gujerat, the ryots refused to pay the half-yearly assessment on their lands. Their refusal was so prolonged, and at last became so menacing, that the Government of Bombay were on the point of sending up a detachment of European troops to enforce payment; when Sir Barrow Ellis, an Israelite indeed, in whom there was no guile, shocked by the proposal, said: "There's George Pedder, he knows these people well. Send him up, as a last resource, and see what he can do with them." Pedder was sent, and asking the assembled ryots why they had not paid up, they at once replied: "A devil is in possession of the wells, and it is for him to pay." "Right," said Pedder, "I'll issue the Sircar's summons to the devil to pay." "Yes," they replied, "and lay it down here, and we will all come again to-morrow morning, and you will find the money on the summons." "But," said Pedder, "suppose I don't." "Oh, then," they at once exclaimed, "it will be plain the devil is not in possession of the wells, and we will of course pay." They paid, and rejoicingly, and there and then at once made ready a bountiful breakfast for Pedder, of fresh baked *chupatis* [griddled pat-a-cakes], and fresh drawn milk, and fresh gathered fruits; and to this day you will, I venture to say, find George Pedder's name of great praise in their mouths, and of their children. *That* is their Indian way, and assuredly it is the wiser way, if but for its peacefulness and pleasancy.

GEORGE BIRDWOOD.

THE WEAVING INDUSTRY OF EGYPT.

With reference to the article on the above subject, which appeared in the *Journal* of February 16th last, it should have been mentioned that the facts were derived from a pamphlet entitled "L'Industrie du Tissage en Égypte," by Mr. Sidney H. Wells, Director-General of Agricultural, Technical and Commercial Education in Egypt (Le Caire: Imprimerie de l'Institut Français d'Archéologie Orientale). The pamphlet contains a great deal of valuable information, and deserves the careful attention of all interested in the subject.

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GENERAL NOTES.

Exhibition of Articles and Appliances used for Packing.—The Orleans Railway Company are organising an exhibition of articles, materials and appliances used for the packing and conveyance of goods of every description, but more particularly with regard to poultry, meat, fish, fruit, vegetables, butter, eggs, etc. The exhibition will be held simultaneously with the four great agricultural meetings this year, at Bourges, Libourne, Limoges and Poitiers. Prizes will be given for the best plans for packing household provisions. The methods used for packing must be simple, practical and economical. As each exhibit must bear the name and address of the maker, an excellent opportunity for advertising their goods will be thus afforded to exhibitors.

The World's Petroleum Production.—The world's output of crude petroleum in 1910 was 327,472,256 barrels of forty-two gallons each, against 298,326,073 barrels in 1909. Of this amount the United States alone produced 209 million barrels, Russia 70 millions, Galicia 13 millions, Dutch East Indies 11 millions, Roumania 10 millions, and India 6 million gallons. The Canadian production has been decreasing steadily since 1907, while the imports into that country have been on the increase. Production of oil did not increase greatly in Mexico during 1910, but the results of explorations in that year made large supplies certain, and gave to Mexico the competitive position towards the United States that has long been imminent. Mexico's production of crude petroleum rose from one million barrels in 1907 to over three millions in 1910, while the Mexican imports of crude and refined petroleum from the United States increased from 19 million gallons in 1908 to 48 millions in 1910. In spite of continued unfavourable conditions, the production of crude oil in Russia during 1910 increased four million barrels over the preceding year. This was due to the increased production of the Grosny, Surakhany, and other new fields. The Baku district, which contributed the greater part of the product, remained almost stationary. In Galicia the production declined for the first time for years, on account of low prices for crude and refined oil, due to sharp competition for a market insufficient for the supply.

The Population of the World.—The population of the world, according to Herr Gulischambarof, a Viennese *savant*, is estimated at upwards of 1,700 millions. With regard to sex, data are only available for 1,038 million of this number, or 521,700,000 males and 516,300,000 females, being in the proportion of 990 females to 1,000 males. In Europe and Africa the number of females is greater than that of the males, being in the proportion of 1,045 females in Africa and 1,027 in Europe to 1,000 males. In the other parts of the world the females are less numerous, being 964 in America, 961 in Asia, and 937 in Australia per 1,000 of the opposite sex. In certain districts in Africa, however, the proportion of females to that of the males is even greater, for instance in Uganda, where there are 1,467 women to 1,000 men. On the other hand, in the western States of North America, British Columbia, and east Australia, the number of males far exceeds that of the females, as for instance in Alaska, where there are only 391 females to 1,000 males, and in the Malay States, where the proportion is 389 to 1,000 only.

Failure of Chinese Human Hair Supplies.—Experts in the human hair trade in Hong-Kong are calling attention to the fact that the disposition of buyers of human hair in Europe and the United States to expect a great over-supply of the material as a result of social and other changes, including queue-cutting, in China, is likely to lead to disappointment. Instead of an over-supply, the changes now going on are cutting off the chief sources of supply in China, and there is likely soon to be a decided falling away. The situation hangs upon the disposal of the queues of Chinese men. Contrary to the general impression in Europe and America, the queues when cut are not sold. This is an absolute rule, so far as south China is concerned, and the American Consul-General at Hong-Kong says that it is the custom all over those parts of China from which he has been able to secure reliable data on the subject. The queues when cut are preserved, according to general statement, for burial with the owner. The chief supply has come from Chinese barbers' shops where, in the course of shaving portions of the heads of customers, a good deal of long hair is accidentally removed. Now that queues are cut, however, Chinese barbers have no more long hair to dispose of than barbers in Europe and America.

Bolivian Rubber.—Next to tin, the most important product of Bolivia is rubber, the annual export value of which is estimated at a million sterling. The exploitation of the rubber lands is regulated by law through an annual export tax. The principal areas lie in the north-east, near the Peruvian boundary; in the east, in the province of Santa Cruz; and in the Acre and Beni territory, which is exceptionally rich in its yield. The Acre territory is watered by several large rivers originating in the Cordillera and flowing into the Amazon. These are the Beni, Madre de Dios, the Orton and the Acre. Two varieties of rubber plant are found; the "caucho," which has to be cut down in order to extract the sap, and the "hevea," which is merely tapped. In some cases the trees are tapped for a period of two years, and are then left for a similar period. Other rubber trees are tapped for six years at a time, and then left untouched for a like period. The trees selected for tapping are usually from thirty to forty years of age, and are expected to yield for twenty years, after which they become useless.

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The Bronze Powder Industry of Germany.—Nuremberg is the centre of the bronze powder industry of Germany. With the exception of one factory at Munich, and one at Frankfort-on-the-Main, all bronze powder factories of any magnitude are found in Nuremberg and Fuerth, and the smaller towns in the vicinity. The raw materials used in the manufacture of the better kind of bronze powder are copper and zinc. For cheaper kinds, various descriptions of metal scraps from the toy and other factories are mixed with these two basic metals. The metals, mixed in graphite crucibles, are placed in furnaces, where they are reduced to a molten mass in about five hours and then poured into moulds and cast into half-round ingots about twelve inches in length and about five-eighths of an inch in thickness. The ingots are flattened under water-power hammers, and passed through rollers under great pressure until they are extended into metal ribbons many yards in length. Before becoming so brittle as to break, these ribbons are annealed in a furnace which is fired only with wood. They are then cut into strips about two yards long, tied into bundles of approximately 100 each, and hammered out still thinner. After being subjected to another annealing process two or three of such bundles are tied together and again hammered. At this stage the thin metal sheets are put through a cleaning process, tied into still larger bundles, and again beaten out under the hammer. When the required thinness is secured, the sheets are cut and torn into shreds and placed in hermetically closed iron boxes, in which they are pounded into a powder under vertical iron stamps. They are passed from one stamp-mill to another until reduced to the fine metallic flour known as bronze powder.

The Fisheries of Eastern Siberia.—Fish are caught in eastern Siberia by means of weirs and nets. The weirs are of two varieties, the "giliak," or native type, and the Japanese type, known as the "ta-te-ami." Both types are similar in construction. According to the American Consul at Vladivostok, the "giliak" type consists of a fence of willow poles and branches built from the river bank or from a sand-bank. The fence is built out as far as the fairway, and turns at right angles down stream. At the end of the second section of the fence, a net is set by means of ropes so placed as to indicate the presence of fish in the net, and the net is closed when twenty to thirty fish have been caught. The fish are then placed in a boat, and the net re-set. During this operation two men are employed. In the Japanese type the net arrangement is more productive, as in place of a bag-net a draw-net is used in connection with a fish-pond made of net or wire. When a sufficient number of fish are in the net they are driven into the pond, where they are kept alive until they are taken into the boats. This type of trap catches many thousands of fish per day. From ten to thirty men are employed, depending upon the size of the net.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

May 8.—E. D. Morel, "British Rule in Nigeria." Sir Edouard Percy C. Girouard, R.E., K.C.M.G., D.S.O., late Governor of Northern Nigeria (1908–9), and of the East African Protectorate (1909–12), will preside.

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S., will preside.

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

Indian Section.

Thursday afternoon, at 4.30 o'clock:—

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

Colonial Section.

Tuesday afternoons, at 4.30 o'clock:—

May 7.—Alan Burgoyne, M.P., "Colonial Vine Culture." The Right Hon. Sir Walter Hely-Hutchinson, G.C.M.G., late Governor of Cape Colony, will preside.

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Howard Lectures.

Monday evenings, at 8 o'clock:—

Captain H. Riall Sankey, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

Syllabus.

Lecture II.—May 6.—Various types of Diesel engines—Considerations affecting design—Design of various parts, such as cylinders, valves, pistons, connecting rods, crank shafts, frames, air compressors, etc., for 4-cycle and for 2-cycle engines—Materials used for the various parts—Number and arrangement of cylinders for vertical and horizontal engines.

Lecture III.—May 13.—Description of Diesel engines manufactured by various makers—Sizes in current manufacture and future possibilities—Speeds and weight for land and marine engines—Various kinds of oil available for Diesel engines; their characteristics, calorific value, and sources of supply.

Lecture IV.—May 20.—Economical results in respect of fuel and of total annual cost—Comparison of Diesel, gas and steam engines, in respect of capital cost, fuel cost, and total annual cost—Various applications to land and marine purposes—Other heavy oil engines—Semi-Diesel engines.

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MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lecture.) Captain H. R. Sankey, "Heavy Oil Engines." (Lecture II.)

Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. A. E. Humphries, "Home-Grown Wheat."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. W. Yorath Lewis, "The Effect of Intermittency in Limiting Electric Traction for City and Suburban Passenger Transport."

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Mr. R. Lessing, "A New Apparatus for the Coking Tests of Coal." 2. Mr. H. E. Williams, "A New Method for the Determination of Ferrocyanides." 3. Mr. J. H. Coste, "A Drying Oven." 4. Messrs. E. W. Lewis and H. Waumsley, "Indiarubber as a Protective Colloid."

Surveyors, 12, Great George-street, S.W., 7 p.m. (Junior Meeting.) Mr. J. Bunny, "Principles of Silviculture."

Geographical, Burlington-gardens, W., 8.30 p.m. Mr. C. L. Temple, "United Nigeria."

Victoria Institute, 1, Robert-street, Adelphi, W.C., 4.30 p.m. Mr. M. N. Tod, "International Arbitration in the Greek World."

TUESDAY, MAY 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. Alan Burgoyne, M.P., "Colonial Vine Culture."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. B. Browne, "Insect Distribution, with special reference to the British Islands." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m. Mr. E. A. Broome, "The Nord End from Macugnaga."

Literature, Royal Society of, Caxton Hall, Westminster, S.W., 3 p.m. (Browning Centenary.) 1. Sir Arthur Pinero, "Browning as a Dramatist." 2. Mr. Henry James, "The Novel in the Ring and the Book."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. W. Bickerton, "The Practical Side of Bird Photography, and its Value in the Study of Natural History."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Dr. Francis Ward, "Lantern and Kinematograph Demonstrations of Photographs of Fishes and Aquatic Animals in Natural Illumination." 2. Mr. G. A. Boulenger, "On a Collection of Fishes made by Mr. A. Blayney Percival in British East Africa to the East of Lake Baringo." 3. Mr. Rowland E. Turner, "Studies in the Fossorial Wasps of the Family Scoliidæ, Sub-families Elidinæ and Anthoboscinæ." 4. Mr. Abel Chapman, "Notes on the Spanish Ibex."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mrs. Henshaw, "Mountain Trails in the Rockies of Canada."

WEDNESDAY, MAY 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. D. Morel, "British Rule in Nigeria."

Biblical Archæology, 37, Great Russell-street, W.C. 4.30 p.m.

Automobile Engineers, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. R. G. L. Markham, "Internal Combustion Engines for Marine Work."

Literature, Royal Society of, 20, Hanover-square, W., 5.15 p.m. Professor Henry Newbolt, "Poetry and Personality."

THURSDAY, MAY 9...Automobile Engineers, 13, Queen Anne's-gate, S.W., 8 p.m. (Graduate Section.) Mr. H. Burchall, "Tyres."

Royal, Burlington House, W., 4.30 p.m.

Antiquaries, Burlington House, W., 8.30 p.m.

Child Study Society, at the University of London, South Kensington, S.W., 7.30 p.m. Annual Conference. Presidential Address by Sir James Crichton Browne.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 4.30 p.m. Annual General Meeting.

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. Norman Collie, "Recent Explorations in the Canadian Rocky Mountains." (Lecture II.)

Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Extraordinary General Meeting to consider New Articles of Association.
8 p.m. 1. Messrs. S. W. Melsom and H. Eastland, "The Behaviour of D.C. Watt-hour Meters more especially for Traction Loads." 2. Professor D. Roberston, "Electric Meters on Variable Loads."

Mathematical, 22, Albemarle-street, W., 5.30 p.m.

FRIDAY, MAY 10...British Science Guild, at the Chemical Society, Burlington House, W., 8.30 p.m. Mr. A. E. Martin, "Coal."

Royal Institution, Albemarle-street, W., 9 p.m. Professor W. Stirling, "The Gaumont Speaking Kinematograph Films."

Malacological, Burlington House, W., 8 p.m. 1. Mr. Harold Hannibal, "A Synopsis of the Recent and Tertiary Freshwater Mollusca of the Californian Province." 2. Mr. A. J. Jukes-Browne, "*Dosinia lucinalis* Lam. and its Synonyms." 3. Mr. Tom Iredale, "New Generic Names and New Species of Marine Mollusca."

Astronomical, Burlington House, W., 5 p.m.

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 8.30 p.m. Sir J. Alfred Ewing, "The Inner Structure of Simple Metals."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Mr. Alex. J. Gayes, "Notes on Telephone Exchange Equipment."

Physical, Imperial College of Science, South Kensington, S.W., 8 p.m.

Child Study Society, at the University of London, South Kensington, S.W., 10.30 a.m. Annual Conference. 1. Dr. J. Kerr Love, "Influence of Defects of Hearing in Relation to the Mental and Physical Development of the Child." 2. Mr. B. P. Jones, "Demonstration with ex-Scholars on what may be done for the Hard of Hearing by a Teacher of the Deaf." 3. Mr. N. B. Harman, "Influence of Defects of Vision in Relation to the Mental and Physical Development of the Child." 4. Dr. Jane Walker, "The Tuberculous Child."
8 p.m. Dr. C. W. Saleeby, "Eugenics and Child Study."

SATURDAY, MAY 11...Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Plunkett Greene, "Interpretation in Song. Lecture I.—Equipment."

Child Study Society, at the University of London, South Kensington, S.W., 10.30 a.m. Annual Conference (continued). 1. Dr. Theo. Hyslop, "Mental Hygiene in Relation to the Development of the Child." 2. Mr. J. Gray, "Demonstration on Appliance for Estimating Mental Aptitudes." 3. Dr. G. Eric Pritchard, "Instruction of the Young in Sexual Hygiene."

Meteorological, Temperance Institute, Southport, 8 p.m. Mr. W. Marriott, "A Chat about the Weather."

Municipal and County Engineers, Nuneaton, 11.30 a.m. (West Midland District Meeting.) Mr. F. C. Cook, "Ten Years' Municipal Work in Nuneaton.'

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Journal of the Royal Society of Arts.

No. 3,103. VOL. LX.

FRIDAY, MAY 10, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MAY 13th, 8 p.m. (Howard Lecture.) CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." (Lecture III.)

WEDNESDAY, MAY 15th, 8 p.m. (Ordinary Meeting.) ERNEST KILBURN SCOTT, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." SIR WILLIAM RAMSAY, K.C.B., Nobel Laureate, F.R.S., will preside.

THURSDAY, MAY 16th, 4.30 p.m. (Indian Section.) NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways." THE RIGHT HON. SIR EDGAR SPEYER, Bart., will preside.

Further details of the Society's meetings will be found at the end of this number.

HOWARD LECTURE.

On Monday evening, May 6th, CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., delivered the second lecture of his course on "Heavy Oil Engines."

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, May 7th; THE RIGHT HON. SIR WALTER HELY-HUTCHINSON, G.C.M.G., late Governor of Cape Colony, in the chair. A paper on "Colonial Vine Culture" was read by MR. ALAN H. BURGOYNE, M.P.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, April 25th, 1912; THE RIGHT HON. LORD MACDONNELL, G.C.S.I., K.C.V.O., in the chair.

THE CHAIRMAN, in introducing the lecturer, said Sir John Miller had recently been a member of the Government of India, and before that time was Chief Commissioner for the Central Provinces. There could be no better exponent of the charms and the interests of those Provinces than Sir John Miller.

The paper read was—

THE CENTRAL PROVINCES.

By SIR JOHN O. MILLER, K.C.S.I.

Ever since I accepted the invitation of the Society to read a paper on the Central Provinces, I have been conscious of being open to the charge of presumption in attempting to speak of a part of India with which my connection has been but brief. Many descriptions of Indian Provinces have been given here by members of the Indian Services, who had a long and distinguished career in the particular tract they dealt with. They brought, not only enthusiasm, but much local patriotism to their task; they spoke under that fascination which any and every part of India seems to exercise on the Englishman who has spent much of his life there; and they were able with sincere conviction to point to the pre-eminent claims which their own Province had to your interest and admiration.

I have not the same advantage, and in case I should fail to do justice to what has been called the "Cinderella of the Indian Provinces," it is right to explain that my acquaintance with the Central Provinces, though much longer than the proverbial six weeks which suffices for a book on India, is yet much too short for the intimate knowledge of a particular tract expected

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by this Society in a paper. To a great extent I am an outside critic, and if in these circumstances an excuse is required for my appearing here, I would ask you to find it in this, that the Province has deeply interested me, that I should like, if possible, to convey some of that interest to you, and that no one out of the many persons who are far better qualified to do so has as yet made the attempt. If I can whet your interest to the extent of making you desire further information from some one who can speak with greater knowledge and authority, I shall be amply satisfied.

In speaking of the Central Provinces, except where the contrary is expressly stated, I mean the Central Provinces and Berar—the administrative unit under the Chief Commissioner. To the usual claims of Provincial pre-eminence these Provinces make no pretensions. They are amongst the poorest, they are the most retiring, and, except by the sportsman, the least known and the least regarded of the Provinces of India. They were also at one time the youngest, but it is hard to say what Province has now the best claim to that distinction. They have no great and renowned cities; they contain no archæological remains of world-wide fame, and no architectural monuments that attract the tourist; they have no frontier problems to keep them in the public eye, and even their natural beauties are almost inaccessible except to dwellers in tents. They have not a single newspaper of importance. The traveller, perforce, passes through them; if he goes to the north he may take a momentary interest in the frowning fortress of Asirgarh, guarding the entrance to the valley of the Nerbudda, or on the Calcutta route he may be charmed by glimpses of forest scenery; he may even make a brief stay at Jabalpur to see the Nerbudda swirling through the marble rocks, but unless he is bent on sport he hurries on, scarcely knowing what part of India he has been traversing. Nor do the Provinces lay themselves out to tempt to a prolonged stay; the lack of good hotels and of good communications tells its own tale of the general absence of interest in the secluded Province that occupies the centre of the country.

And yet it is extremely interesting, and no Province perhaps brings into such vivid juxtaposition the contrasts and diversities that characterise India as a whole. It is a microcosm of India, of India's history, and of India's problems. It is a common remark, for instance, that there is no Indian nation. Nowhere is the meaning of that remark brought out more clearly than in the Central Provinces, and the comparative absence of the Mohammedan element only serves to give point to the general proposition. A remark of the missionary geologist, Dr. Hislop, whose name is still preserved by the college he founded at Nagpur, is instructive and worth remembering. Speaking of that place, he showed how it was in a sense at the geological centre of the Peninsula. West of it lie the hills of trap that stretch to the Arabian Sea; east of it are the massive piles of granite that extend to the Bay of Bengal. "Walk round Sitabaldi," he said—Sitabaldi being a small hill in Nagpur, of which there is more to be said later—"and you may meet almost every rock that is to be found between Bombay and Calcutta." And the geological analogy may be extended to almost every aspect of the description of the Province. North and south, east and west, old and new, here meet and contrast themselves. Ethnologically the contrasts range from the up-to-date enterprise of the Parsi, whose influence here, as elsewhere, is out of all proportion to his numbers, and the keen and vigorous intellect of the Marathas, to the primitive simplicity of forest tribes who still arm themselves with bows and arrows. In religion there is always in India the contrast between the most elevated and spiritual forms of communion with the unknown and the lowest forms of fetish worship, but nowhere else is it forced so prominently on the attention. There are those who rigidly observe the strictest tenets of Brahmans and Jains, and there are forest tribes that do not abstain from feeding on lizards or mice or snails. In the north and east the common language is a dialect of the Hindi of northern India, in the west it is the Marathi of Bombay; while on the southern and eastern fringes there are people who speak only the Telugu of Madras, or the Uriya of Orissa. A few miles from a bustling railway station, where the merchants are struggling for precedence of their cargoes of cotton or rice, or oil-seeds or wheat, you may meet a caravan of Banjaras, still plying their old trade as the transport corps of India—the children sleeping on the backs of the pack animals, the sturdy men and stalwart women striding alongside, with an escort of dogs of different breeding and temper from the village pariah. In administration there are in operation both the great Indian systems of revenue settlement, the *ryotwari* of Bombay and Madras, and the *zamindari* of Hindustan; in excise the arrangements common in Upper India are being replaced by others borrowed from the

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south, and similar contrasts might be indefinitely elaborated.

The Central Provinces lie on the northern border of the old Indian continent, not far from where it must once have been washed by the sea before the Himalayas arose and the great plains of Upper India were formed. One swarm of immigrants after another has swept down those fertile plains, bringing new and more vigorous civilisations with them, and spreading into the more accessible parts of the Province itself, while higher up in the hills and forests the life of the aboriginals in the jungles has been till lately hardly affected. It is with a feeling almost of regret that one turns from the freshness and simplicity of life in the forests to the hard facts of history and administration; but there need be the less reluctance to do so as the backward tracts of the Central Provinces have been fertile in literary inspiration. You may read of them in Forsyth's fascinating "Highlands of Central India," or in "Camp Life in the Satpuras," and does not Mowgli himself owe his birth to that country?

I would ask your attention for a moment to the physical geography of the tract. The great rivers of India flow generally east and west, and the watershed is, as a rule, far to the west. In the north, in the Himalayas, it is formed by the ridge on which Simla stands, and it is an interesting fact that the British Government should, merely by chance, have chosen the dividing line of the outer Himalayas for the seat of its summer capital. To the south the watershed is in the western ghats not far from the west coast, but between Hindustan and the Deccan a long trough, as it were, projects far into the heart of the Peninsula. The northern side of this trough is formed by the Vindhyas, the southern by the Satpuras.* North of the Vindhyas the drainage finds its way to the Jumna and the Ganges; south of the Satpuras, except in the extreme west, it is intercepted by the Godaveri or the Mahanadi, in all these cases flowing east into the Bay of Bengal. But between the two ranges the watershed is thrown far to the east in the tumbled mass of highlands, in which Satpuras and Vindhyas seem to meet and to lose their identity, away to the east of Jabalpur. There, just beyond the Provincial boundary, rises the holy hill of Amarkantak, over 3,000 ft. in height. On one side, below the old temples which Hindu devotion has raised in this picturesque plateau, is the series of pools that mark the earliest beginnings of the Nerbudda, while across the brow of the hill are the channels that carry the drainage east to the Son, and so to the Ganges and the Bay of Bengal. The priests from the temples suggest that the Nerbudda and Son do not exhaust the sanctity of the locality, and that close at hand is the source of another mighty but invisible river. They do not expect to be believed, but they are not far wrong, for the spot cannot be at any great distance from which the hill streams fall down the southern slopes of the range on their way to join the great river—the Mahanadi. Amarkantak is thus a place the central position of which, on the Indian continent, is worth remembering.

The map of the Province shows that it is entirely surrounded by Native States, except in three places. On the south-east it touches Madras; on the north it is conterminous for a very short distance with the United Provinces; and on the west there is a narrow strip of British territory, in the valley of the Tapti, where the Central Provinces meet Bombay. They are thus very nearly an island amid Native States, and they are formed of districts which either came under our rule at a comparatively late date, or which could not conveniently be administered by any of the earlier and greater Governments. As now constituted, they are composed of territories of which we undertook the administration at three distinct periods—territories differing in their history, their peoples, and their resources, with little indeed in common except that the harrow of the Marathas had passed impartially over them all. The tracts that came under British rule at these three periods are the following:—(1) The Satpura and Vindhyan plateaux (except two districts), and the Nerbudda valley between them; (2) the plains of Nagpur and Chattisgarh, and the districts above the ghats of Balaghat and Chindwara; (3) the country below the western Satpuras—Berar.

The first section was formerly a part of the Saugor and Nerbudda territories, which came under our rule after the war of 1817–18, and were administered before the Mutiny sometimes by a special Agent, sometimes by the Government at Allahabad. They now form two Commissioners' Divisions. The tract is a high-lying one. The lowest part of it—the valley of the Nerbudda—rises from 700 ft. in the west to 1,300 ft. at Jabalpur. On the Satpura plateau the station of Chindwara is at a height of 2,200 ft. above sea-level; while Pachmarhi, to

* The term "Satpuras" is used throughout in its local meaning to denote the hills and plateau south of the Nerbudda.

which the administration moves in the hot weather, is at a height of 3,500 ft.

On the north of the Nerbudda the station of Saugor—one of the most picturesque of British stations south of the Himalayas—is 2,000 ft. above the sea.

The second part of the Province, which also forms two Commissioners' Divisions, is usually referred to as the plains of Nagpur and Chattisgarh, but it is a country of rolling plains, diversified by hill and forest, entirely unlike the level plains of Upper India. The Nagpur country slopes generally to the south, Nagpur itself being 1,100 ft. above sea-level, and Chanda to the south, only 650 ft. It drains into the Godaveri. The general slope of the Chattisgarh plain is to the east, Sambalpur, just beyond its eastern boundary, being only 450 ft. above sea-level. The great river of these parts is the Mahanadi.

Such brief account of the history of the Province as time admits of can most conveniently be given with reference to this second section. Passing over the mass of legend and conjecture, and the particles of truth in the accounts of olden time, the supposed evidence of Scythian nomads in the stone circles and mounds which the antiquarian describes with reference to such familiar terms as barrows and cromlechs, passing over the connection with northern India in the journey of Rama through the forests peopled with strange monsters till he emerged at Ramtek near Nagpur, and passing over all the confused accounts of the dynasties of the Deccan, we may come at once to modern and comparatively authentic times. About 1600 the country was in the hands of a Gond dynasty, ruling first at Deogarh above the Ghats and then at Nagpur, the city of the Nag or hooded snake which protected the founder of the line, and it attained a degree of civilisation and power that we should hardly expect from the unaided efforts of the Gonds as we know them now. A century after, about 1700, towards the close of the long reign of Aurangzib, the Gond prince was a man of unusual ability. He attended the Imperial Court, and he adopted the Imperial religion, but he ruled his people well and wisely. He encouraged the settlement of Hindu cultivators and artisans, and raised his kingdom to a considerable pitch of prosperity, so much so, unfortunately for the Gonds, that on the weakening of the Imperial power it presented an attractive morsel to the rough but vigorous Maratha captains who were carving out kingdoms for themselves from the members of the decaying empire. Just as Holkar and Scindia established themselves in the north, so to the side of Gondwana came another Maratha family, that of the Bhonslas. Taking advantage of family feuds amongst the Gonds, and acting at first as Protectors under the shadow of the nominal suzerainty of the Gond king, they gradually consolidated their own power. The first members of the line were hardy warriors, simple in habits, but rapacious, accessible but ambitious, plain men, but more than able to hold their own in these days of turmoil. By 1800 they had extended their power over the whole of the Province, and, beyond its limits, over Orissa and part of Chota Nagpur. In 1803 they threw in their lot with Scindia against the British. They left him to be defeated at Assaye, but were a few weeks later attacked by Wellington and driven off the field of Argaum in North Berar. In the peace which followed they lost Orissa and Berar, and a Resident was attached to their court, the first being Mountstuart Elphinstone, who had in a civil capacity attended Wellington in the field during the war. Up to that time the Maratha chiefs seem to have treated the people well, but now the reigning Bhonsla attempted to make up for the loss of part of his dominions by excessive exactions from the remainder; while at the same time the unhappy peasants were harried by the Pindaris, and other marauders, who, in these days of anarchy, scoured the whole of the Peninsula from Allahabad to the Gates of Calcutta and Madras. If anyone wishes to understand the state of chaos that made the extension of the authority of the paramount power inevitable, he should read the "Papers respecting the Pindari and Maratha wars," and attempt to realise the full significance of the forts now crumbling to ruins in so many villages of Nagpur and Berar. The seriousness of the situation may be gathered from the magnitude of the preparations made by Lord Hastings to cope with it. In 1817 he organised a combined movement from north and south into the country between the Nerbudda and the Jumna, to be carried out by 90,000 regular troops and 23,000 irregulars. With his campaign against the Pindaris we are not directly concerned, but while the troops were concentrating the Marathas broke out unexpectedly in the rear, first at Poona and a fortnight later at Nagpur, where the Residency and the small hill of Sitabaldi behind it were attacked by an apparently overwhelming force. The defenders consisted entirely of the Company's forces—mostly Madrassis—and the issue for a time was doubtful, but in the end the

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assailants were repulsed, though not till after a quarter of the small garrison had been killed or wounded. Troops were hurried to Nagpur, and, after some further fighting, the Bhonsla chief was deposed.*

The defence of Sitabaldi was considered a notable incident at the time, and, like the defence of Koregaon in Bombay about the same period, it ought not to be forgotten. You will no doubt recollect that during their journey from Calcutta to Bombay their Majesties halted at Nagpur to see the scene of this fight.

Up to 1830 the administration was in the hands of the Resident, and cultivators flocked in from Berar to take advantage of a settled Government. In 1830 the successor to the deposed chief was placed at the head of affairs, and in 1853, on the failure of heirs of the ruling line, Lord Dalhousie, refusing to acknowledge any right of adoption, annexed the country, which, after the Mutiny, was joined with the bulk of the Saugor and Nerbudda Territories to form the Central Provinces proper under the administration of a Chief Commissioner.

The third section of the existing Province—Berar—need not detain us long. Recognised towards the end of the seventeenth century as one of the wealthiest portions of the Mogul Empire, it fell on evil times in the period of anarchy. Marauders from the north poured through the passes of the hills; Gonds from the east, and Hindus from the south, are said to have joined in the plunder, and later on it was subjected to the more systematic depredations of the Marathas, whose right to tribute was definitely recognised in 1716. In 1724 it passed into the hands of the first of the line of Nizams, whose authority, though overlaid at times by the irruptions of the Marathas, just as the country itself is overlaid by the Deccan trap, has ever since been recognised. The Bhonsla Rajas were for a time in virtual possession, but were ousted after Argaum, and shortly before the Mutiny Berar was assigned to the paramount power to meet the expenses of the Hyderabad contingent. A settled rule quickly restored its prosperity, and the emigrants who had fled to Nagpur flocked back again. In 1902 a permanent lease of the Provinces from the Nizam in return for an annual payment of 25 lakhs of rupees was negotiated by Lord Curzon; and the country was placed under the administration of the Chief Commissioner of the Central Provinces. Berar is thus in a curious and anomalous position. Without forming part of British India, it is administered as if it did as far as legal forms will allow, and once a year the dignity of the Nizam is formally recognised by the hoisting and saluting of his flag.

One other point about Berar should be mentioned. Though under Mohammedan rule for nearly three centuries, the vast majority of its people are Hindus, and it has preserved the Hindu character of its organisations, only slightly affected by Mohammedan influences.

The total area of the Province so formed is 100,000 square miles, or rather more than the area of Great Britain, while attached to it are 30,000 square miles of Native States, nearly the area of Ireland. The population is sparse; it now amounts to nearly 14,000,000, a decrease of about a million in the calamitous decade from 1891 to 1901, having been followed by an increase of twice that amount in the succeeding ten years. The recovery from the time of famine in all directions has, indeed, been striking. Bad seasons have not been wanting in the last decade, but the figures of population, showing an increase of 16 per cent., a higher rate than in any other Province, merely corroborate the conclusion to which all indications point that the traces of famine have been obliterated with astonishing rapidity. The Native States population is about two millions. The density of population over the whole area is about 140 to the square mile; in the Native States it is less than half that figure; and in large areas there are not over ten persons to the square mile.

The Province is essentially Hindu, and the people almost entirely rural. Mohammedans

* The Central Provinces escaped comparatively unscathed by the storm of the Mutiny, and the record-rooms in the Government Offices were thus preserved from the destruction that overtook many in northern India. The ponderous volumes of old correspondence in the Nagpur Residency were recently examined and indexed under the supervision of Mr. S. C. Hill, and amongst the documents found was a paper containing the orders of General Doveton for the disposition of his troops in a battle that followed the successful defence of Sitabaldi. It is an interesting document as showing the elaboration with which our generals, long before the days of staff colleges, regulated the formation of their lines in the most minute detail down to the position of the water-carriers and doolie-bearers. A touch of personal interest is given to the paper by a pencilled endorsement of the General's, forwarding it for the Resident to see, and apologising for not doing so in a more formal manner. It is not only at Nagpur that old records have been preserved. In the district offices the mouldering bundles still lie in ancient chests; and among the mass of routine correspondence it is possible that documents may be found throwing light on the conditions of the country when it was emerging from the period of anarchy. Forsyth, for example, has unearthed from the records of Nimar a full account of the last case of human sacrifice—self-sacrifice—at Mandhata on the Nerbudda, in 1822, and if the overhauling of the documents is proceeded with, further light may be thrown on the customs of the time and the problems of early administration.

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number less than 600,000 in all, and form only about 4 per cent. of the population. Some 13 per cent. are classed as Animists, while Hindus, Jains, etc., account for 83 per cent. There has been a remarkable increase in the Christian population during the last decade, the number rising from 26,500 to 34,700. The Province offers to missionary enterprise a hopeful and useful field which has been eagerly occupied. Even in the most backward parts the little mission stations are to be found, forming centres from which higher standards of life are spreading amongst the primitive tribes. In the towns the missions are equally active, the name of Dr. Hislop, to whom an eloquent tribute was paid by Sir Richard Temple, will not soon be forgotten; and his successors of many creeds and denominations unselfishly devote their lives to the welfare of the people among whom they have cast their lot. They take a keen interest in schools and hospitals, and in many of their institutions a practical training in handicrafts is added to the usual course of literary instruction. No account of the Province would be complete without a reference to the useful and valuable part they are taking in its development.

There are few towns of importance, and only two with a population exceeding 50,000, Nagpur the capital with 101,415, and Jabalpur with 100,151 at the last census.

It is impossible to describe a population so diverse as that of the Central Provinces, except in the most general terms. As seen in their bazaars and villages, the mass of the people leave a general impression of a smaller and darker race than the inhabitants of Upper India. They are simple and informal and friendly, and, on the whole, they are less reserved than the races of the north. There is more familiarity and less of the dignified courtesy that is associated with the east; indeed, there is often in the south an absence of the customary signs of respect that may be mistaken for a want of good will. But it is not; it is merely or mainly the fashion of the country; it was noticed nearly a century ago by Sir Richard Jenkins as a characteristic trait, and it is as far removed from intentional rudeness as is the language of a villager in the north when he uses the familiar "*tum*" in place of the respectful "*ap*." The people are, as Indian conditions go, social and light-hearted; and the backward races are fond of drink to an extent that is rare in India. They organise many village sports; some of the tribes delight in dances representing scenes of love or war; and races between the famous trotting bullocks of the country are popular. The women folk are more in evidence than in the north. The Marathas never took kindly to the *pardah;* the country women are free from Eastern restraint; and in higher circles there is a greater adaptability to the social customs of the West than in Upper India, though there, too, a marked change is now noticeable.

The spirit of the administration, as might be expected in a small Province, is one of close contact between rulers and ruled. There are different aspects in which the advantages of such contact may be viewed. There is, for instance, the sentiment expressed by Mrs. Howden, in the "Heart of Midlothian," when she criticised the removal of the magnates of her country to England on the ground that "naebody's nails can reach the length o' Lunnon." Perhaps that feeling is not without its weight even now, but a far more important aspect is that which looks to fostering the quality of sympathy in our rule. We hear much of a widening of the gulf between East and West, and a growing aloofness between administrators and people. Even friendly critics deplore these tendencies as though there could be no doubt of their existence, but personally I believe them to be mistaken. It would present a much more illuminating explanation of recent events to say that it is the narrowing of the gulf that occasionally troubles the waters. As for aloofness, there are undoubtedly influences in the present day that, taken by themselves, encourage its growth, but my own belief and experience is that the civil officers of Government have now a much more intimate acquaintance with the people and country committed to their care, and a more sympathetic consideration for local needs, and tolerance for local prejudices than they ever had in the past. It is too much the habit to compare the average practice of the present with the brightest examples and the highest ideals of the past, and to forget that tributes to the excellence of our civil administration in India have at all times been interspersed with criticisms of the aloofness and superiority and carelessness of the individual civilian. It would be easy to give examples from the time of the Duke of Wellington downwards, but I take one only from the Central Provinces, where Forsyth tells of an officer who, during eleven years' tenure of a district never once set foot in the hilly portion of it, which covered 3,000 square miles, and was inhabited by 40,000 people. So changed are the standards of the present day that neglect of this description seems incredible.

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In the Central Provinces, at all events, there is no aloofness. The prevailing spirit there is one of active co-operation amongst the officers of Government themselves, and of close touch between them and the people. Sir Andrew Fraser, himself a local officer, refers to the strength of this spirit as an effective tradition, but it has also impressed outside observers, such as Sir Frederic Lely and the late Sir Edward Law, and has even given rise to the opinion that a Chief Commissionership is the best form of government for an Indian Province, a suggestion which, in my opinion, misses the real lesson to be learned, and which, in any case, is too far removed from the sphere of practical politics to call for consideration.

Two examples may help to illustrate the working in practice of this spirit. During the time of distress and of common suffering in the famine, officials and people were brought into unusually close and friendly relations. One of the results of those disastrous years was to reduce the cultivators of many districts to a state of apparently hopeless indebtedness. It was felt that something must be done, but there was no legal power to do anything. All that the officials could do was to use their friendly offices and their personal influence in suggesting to the creditors a reference of their claims to unofficial tribunals for arbitration. If the creditors would accept a reasonable compromise, the Government offered to make a similar reduction in its claims for revenue and loans. Long and patient negotiations followed with great good feeling on both sides, and in almost all cases the arbitration was brought to a successful issue.

"In the five districts that had suffered most acutely," says Sir Bampfylde Fuller, "debts amounting to some millions sterling were written off, and thousands of families were rescued from degradation."

Another example may be taken from the sphere of local self-government. When Lord Ripon formulated his famous policy, the Chief Commissioner decided that it should have a full and genuine trial. He would have nothing to do with shams, and he adopted the bold policy of placing all the local bodies under non-official chairmen. In the case of district boards it would be premature to say that any great measure of success has been achieved. That may be due to want of funds, though personally I hold that in the conditions of India, without any reflection at all on the business capacities of the people, official chairmanship is essential to the development of a useful system of decentralising local work in the districts. Be that as it may, the experiment has been fully justified in the municipal sphere. The large cities even of Jabalpur and Nagpur have been successfully managed by these non-official bodies; and the administration has been conducted on progressive lines, very creditable in a poor province. The waterworks with which both cities are provided, and the still larger schemes of improvement that are being undertaken in Nagpur, are striking examples of what may be effected under purely non-official management, when it works in friendly and harmonious relations with the official world. I doubt if there is any city in India of the size of Nagpur, where a similar experiment has been as fully tried, and the Government were undoubtedly fortunate in finding amongst the leading citizens men of such public spirit and such liberal ideas as Sir Bepin Bose and Sir Gangadhar Chitnavis to assist in demonstrating the fitness of the inhabitants for the responsibilities placed on them.

A backward country presents a tempting opening to a forceful administrator, and the Central Provinces in their most backward days came under the sway of an exceptionally strenuous ruler, Sir Richard Temple. Then, it has been said, the "distant valleys and mountain gorges that had heard no other sound than the woodman's axe, echoed to the horse-hoofs of the tireless Chief," and the memory still lingers of his rapid progresses with panting secretaries toiling after him. His policy left a deep impress in the Province, and three of the measures taken in his time must be referred to for an understanding of existing conditions, those namely, which relate to—

(1) Native chiefs; (2) Forests; (3) Settlement of the land revenue.

Many thousand square miles of the Province, lying generally in its most inaccessible parts, were then in the hands of chieftains who exercised a varying degree of quasi-independent jurisdiction. There was no certainty as to their status, and no definite rule for their treatment. Sometimes they were dealt with as the commonest subjects. At others they were held responsible as rulers. A clear distinction was now drawn. A comparatively small number were declared to be Feudatories, Native Chiefs, free to rule their States, subject only to political control and to certain restrictions, such as the reference of all death sentences to the Chief Commissioner. The remainder were pronounced to be ordinary British subjects, but were left for the time being in possession of special privileges. They retained

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control of the police in their estates, and they enjoyed the revenue from excise and pounds and ferries. They were known as Zamindars.

The position of the Feudatories is now one of much dignity and independence, and in a well-managed State the administration reaches a high level. The law courts and dispensaries, the good discipline of the jail, the smartness and intelligence of the police, show what progress has been made from the days of a rough-and-ready patriarchal administration. Occasionally the rate of progress may be too rapid for a primitive people. Grievances are felt or imagined, or there may be intrigues at court and trouble results. A few years ago there was an outbreak in the largest and most remote of the States, which covers an area of 13,000 square miles. The capital was in danger for some days, and there was loss of life before the trouble was put down.

If the development of the country has had, on the whole, the effect of enhancing the dignity of the Feudatories, its result has been otherwise with the Zamindars. The exercise by them of special privileges was anomalous; it was contrary to the law, in the eyes of which they were merely ordinary subjects, and as the country was opened up it could not hope to escape challenge. The Zamindars have had to submit to a process analogous to that which deprived the Highland Chiefs of Scotland of their hereditary jurisdictions. The Government has taken over the police, and is gradually assuming the administration of excise, pounds and ferries, after payment of compensation. Litigation unfortunately arose during these proceedings, and was only terminated this year by a decision of the Privy Council. The way is now open for the prosecution of measures that have long been in contemplation, but have been obstructed by the disputes that arose, for preserving the Zamindars' estates from the danger of being broken up—a danger that unfortunately becomes to people of their class more threatening with the progress of law and order.

In the tracts which have been set aside as forests in the Central Provinces, the State possesses a property of vast size and of increasing value. Outside of Burma no province has an equal area or an equal proportion of reserved forest. In the United Provinces, rather less than 4 per cent. of the total area is so classed; in Madras and Bombay the proportion rises to 11 and 14 per cent. respectively; in the Central Provinces it is 22 per cent., the actual area being 22,000 square miles. Of the tracts originally classed as forest, considerable portions have since been given over for cultivation, and the process is not yet complete. Of the remainder, much is of the poorest description, and would long ere now have disappeared altogether from the category of forest, but for the recognition, when the Province was formed, of the necessity of immediate steps to prevent the wholesale destruction that was in progress. Amongst the jungle tribes the practice was common of burning the forests to secure a few years' temporary cultivation. As an indignant forest officer said, they "had for centuries devastated the forests to form ashes to manure their wretched fields of half-wild grain." We need not, however, condemn them too severely. It may be that in the future their recklessness will appear venial by the side of the recklessness with which civilisation uses up, not merely forests, but the mineral treasures which Nature has spent untold ages in accumulating. To the jungle tribes the forests must have seemed inexhaustible, and were this not the case, they might well have argued that fresh means of cultivation would present themselves with more reason than we now assume that Nature will provide, or our own inventiveness procure, fresh sources of power when we have exhausted those on which our present prosperity is based.

The forest tribes were not the only destroyers. The advent of the railway, and the opening up of the country, brought timber contractors, who threatened even more irreparable damage, and who did, in fact, cause immense and wasteful destruction before Government stepped in. The forests were thus in large measure exhausted when taken over. After half a century of conservation their value is now becoming manifest, though the revenue they yield is still small. In a recent year it was £150,000, not so much as the United Provinces receive from less than one-third of the area. There are a few tracts in which valuable timber is produced, chiefly *sal* or teak, but it is not for their large timber but for their minor products that the forests are most valuable, poles, bamboos, myrobalans, lac, mhowa, and above all for their grazing. The character of the produce has secured a ready acceptance of the principle that forests are maintained primarily for the benefit of agriculture; and it may be doubted whether the administration has been so completely conducted on this principle in any other Province. Subject to certain necessary exceptions and qualifications, all agriculturists can obtain the forest produce they require at specially low rates. As facilities for access to the forests are increased, some restriction in the

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exercise of these privileges will become inevitable, and a solution may perhaps be found in the grant of definite quantitative concessions to villages established near the forests, whose good-will and co-operation it is desirable to secure, and who but for forest laws would have free access to forest products. People at a distance from the forests would then be left to the ordinary commercial methods of supply.

The preservation of the forests of the Central Provinces is a matter of more than Provincial importance. The whole of the uneven and mountainous country in the centre of India was at one time covered with thick forest. Much of it still is; but many tracts of fertile soil have, very rightly, been brought under the plough, and much of the remainder, being in private hands or in Native States, is being rapidly exhausted. On a hot day in April I have seen the woods blazing near the top of Amarkantak to make a clearance for cultivation, while over the forest below, away to the east, blue smoke wreaths showed that the same process was going on in all directions as far as the eye could reach. In Chota Nagpur, still further east, the destruction of the jungle has been so serious that the Government of Bengal appointed a committee to suggest remedial measures; and attention has been drawn to the increasing violence and frequency of floods in Orissa, owing to the destruction of forest in the catchment area of the rivers. It may be that India will, like other Continental countries, be obliged hereafter to place some restriction on the destruction of private forests, and while public opinion is being educated to this point it is well for the country that in the high tableland where so many rivers have their origin, or whence they draw part of their supplies, there is a large area beyond the reach of reckless or wilful devastation.

The form which the revenue administration takes in an Indian Province is determined partly by the practical consideration of how best to continue existing conditions and customs, and partly by the theories of the time as to the system that is best in the abstract for the people and the country. The Central Provinces offer an excellent example of the working of both these influences. Our predecessors were the Marathas, and in the Maratha country proper it was the custom for the State to collect its revenue direct from the peasantry, without the intervention of any middleman. In Berar this system has been followed, just as it has been in the contiguous Presidency of Bombay. The settlement is made with the peasant proprietors direct, and a percentage given to the headman for collecting it. The headmen and village accountants are hereditary officials, with a status of considerable dignity, the possession of which excites much competition and litigation amongst all who can show any title to it. The revenue is not heavy, and is collected with remarkable ease and absence of friction. In the rest of the Province the Marathas were unable to apply the same definite methods as in Berar. Not only were they invaders, but the people for the most part were of a different race. They took the revenue as they could; sometimes they collected from headmen, sometimes they made the villages over to revenue-farmers and collected from them. Up to the Mutiny, our own arrangements were indeterminate and varied, and when the time came for a final decision to be made, a strong feeling existed as to the advantage of giving a stake in the country to landlords who could act as the natural leaders of the people. The orders were to ascertain the persons best entitled to the proprietary possession of the land, to recognise in them full rights as proprietors, and to make the settlement with them.

This policy was not carried out without difficulty, and in some parts it might almost be said that the authorities had to go out into the lanes and highways to find persons on whose unwilling shoulders the burdens, as they were then regarded, of landlordship might be thrust. But found they were, and the orders were given effect to with a thoroughness that led in the usual sequence of events to an inevitable reaction, and to severe criticism of the policy. That the measures were too sweeping may be admitted, but there were many parts in which the claims of middlemen could not have been overlooked without injustice, and many others in which it might very reasonably be held that the intervention of a landlord between State and cultivator was in itself desirable. Local opinion, however, and local phraseology have never frankly accepted the English conception of landlord and tenant. The landlord is not known by his usual title elsewhere of *zamindar* or land-holder; he is the *malguzar*, the person who makes the revenue good. The distinction is more than nominal; a higher percentage of the assets may be taken from the *malguzar* than is customary elsewhere, and his tenants enjoy an exceptional degree of protection against exaction on his part. From the very beginning the security of the tenants was carefully provided for. Occupancy rights of various kinds were freely recognised, and later on, when good seasons and the progress of the country had enhanced the value of land, more stringent measures to prevent unfair enhancement of rent were taken.

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Fair rents, with which the landlord has only a limited power of interference are now fixed authoritatively for all classes of tenants alike. The cultivator is thus amply protected; the social and economic effects of the system in other directions can only be judged as the country develops. It tends to make the landlord a mere assignee of rents, and to keep rents themselves at a low level. A weak landlord must accept the position; a strong one endeavours partially to avoid it by extra legal methods. Low rents are not always an unmixed advantage in the long run. All depends on the character of the cultivator. They may encourage careless cultivation or tempt the tenant to sub-let his land and become a petty and tyrannical landlord. One observer has recorded of the cultivators of Chattisgarh that they were better men when the struggle for existence was keener, and it is at least an arguable position that in the backward parts of the Province a less sweeping measure of protection might have sufficed.

The total land revenue of the Province in 1909–10 was £1,250,000, of which a little less than half was contributed by the four districts of Berar, and a little more than half by the eighteen districts of the Central Provinces proper. In Berar the incidence of the revenue per head of the population is just over Rs. 4 or, say, 5*s*. per head, in the Central Provinces it is 1*s*. 8*d*. In the cultivated area the incidence is about 2*s*. in Berar, and 9*d*. in the Central Provinces. Judged by the population, the incidence is high in Berar; it is almost exactly the same as in Scinde, but is higher than in any other Province except Burma; in the rest of the Province the incidence is light, but not markedly so. If, however, regard be had to the cultivated area then the incidence in Berar is by comparison with other Provinces low, and the incidence in the rest of the Provinces is extraordinarily low. Berar is then almost on a level with the Punjab, and its revenue rate is lower, generally substantially lower, than that of any other temporarily settled Province. As a fact, its assessments are generally admitted to be distinctly moderate. In the remainder of the Province the incidence is much less than half of what it is in Berar—only 8*d*. or 9*d*. per cultivated acre—and the assessments have been criticised at times as being unfairly lenient in comparison with other parts of India. That is not the opinion of the local taxpayer. These apparently light assessments are the subject of not infrequent complaint, and in many districts where bad seasons have sapped the resources of the cultivators, it has been necessary to introduce elaborate and complicated methods of easing the burden. The explanation of the comparative unproductiveness of the land settlements must be found in the extremely inferior character of much of the cultivation, the uncertainty of the return, the absence of irrigation facilities, the lowness of the rents in many parts, and the obstacles that make any rapid raising of rent impossible. Any attempt to raise the assessments merely because they appear from statistics to be low would be ruinous to the country, and not long ago, in reply to a representation on the part of the landlords, the Government gave an assurance of moderation.

Enjoying a secure tenure at a moderate rent, the cultivating classes of the Central Provinces require only good seasons to ensure their prosperity. There was a time in the past when, during a succession of such seasons, their prosperity advanced rapidly; and as they were regarded as immune to serious famine, no interruption in their development seemed possible. But the disastrous decade from 1890 to 1900 dashed all these hopes and threw the Province back for a time. Rust, the result of a cycle of years of heavy rainfall, attacked the wheat; one poor season followed another, and when the resources of the people were sadly exhausted, first one famine and then a second came upon them. In the second of these—the great famine of 1899–1900—the Central Provinces suffered almost more severely than any part of India. The direct expenditure on relief operations was over one million sterling in 1899, and nearly two millions in 1900. Over one-fifth of the entire population was at one time in receipt of relief from the State. Since then prosperity has returned, but warnings of the precariousness of much of the cultivation have not been wanting, and in 1907–08 a third serious drought threatened yet another season of calamity. The people were, however, in much better condition to meet the trouble; above all, there was a great demand for labour, and relying on these facts, and on his own intimate knowledge of the country, the Chief Commissioner felt justified in making some departure from the ordinary policy of famine administration. Every famine in India brings fresh problems, and in this case the result showed that the new conditions had been fully and accurately gauged. The total cost of relief was so low—not exceeding £100,000 in all—that the seriousness of the situation has hardly been recognised

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except by those in intimate touch with the facts; and I cannot do better here than quote the words of Sir Reginald Craddock, as he looked back at the close of his administration in the three famines through which the Province had passed.

"The famines," he said, "were a time of gloom and of almost hopeless despondency. In the first the officers of Government had to gain their experience, and the people had to be helped in spite of themselves. In the next famine the experience had been learned by the officers, yet there had set in a great demoralisation of the people who clamoured for help to an unreasonable degree, and expected Government to do everything for them. Then there came a great change of attitude, and in 1907 and 1908, when there was famine in several districts and severe scarcity in all, it was not a case of helping people in spite of themselves. There was no longer any demoralisation; all we had to do was to put the people in the way of helping themselves, and they did help themselves. I am confident that should Providence have in store any future famine or failure the same spirit of self-help on the part of the people will characterise the administration of relief."

It is in this spirit that the task of helping the people to protect themselves against future failures of the rains has been undertaken. Much has already been done, but what has been done is small in comparison with what has been projected, and if the financial situation permits, the condition of the precarious districts will in another decade be entirely changed. Hitherto the Central Provinces have had but little experience of irrigation. In the rice-tracts, indeed, the crops have been watered, to a certain extent, from tanks, some of these being magnificent artificial reservoirs constructed by former rulers but not specially adapted for irrigation, and others being mere ponds that rapidly dried up in bad years. Outside the rice-tracts there was practically no irrigation, except of small patches of sugar-cane or garden crops. The creaking of the rope and wheel, and the gurgling of the water at the wells, so familiar in the fields of northern India, are rarely heard here.

When the Irrigation Commission visited the Province in 1903 they found public opinion doubtful as to the possibility of any reasonably remunerative system of irrigation on a large scale, and their recommendations took their tone from the local spirit of caution and hesitancy. But they fully recognised the potential value of reservoirs for the construction of which the configuration of the country was specially favourable, and, while unable to hold out much hope of a financial return on the outlay, they recommended a bold policy of experiment. This policy has been fully carried out, and already the attitude of hesitancy has disappeared. Tanks have been constructed in great numbers, chiefly in the rice-tracts; the larger ones deserve the name of artificial lakes, and their value is so much appreciated that the Government is pressed by public opinion to quicken its pace. The largest of these reservoirs, at Ramtek near Nagpur, impounds the drainage from a catchment area of eighty square miles, and is intended to irrigate from 60,000 to 80,000 acres. The experience gained has already justified much bolder undertakings, and projects have been sanctioned for the construction of canals from three of the great rivers, which will irrigate hundreds of thousands of acres, and when completed will revolutionise the economic and agricultural conditions of large areas in the southeast of the Province. On one of these canals work has been commenced.

Admiral Mahan, in one of his works, makes a remark to the effect that war may be excited by the benevolent emotions, but that it cannot exist on them. It is the same with irrigation. Tanks may be made in time of famine without regard to their cost, merely to provide labour for a starving population; other works may be pushed on in ordinary seasons because their need in time of drought is so great as to exclude commercial considerations; but no rapid expansion of irrigation facilities is possible unless the works are remunerative. The taxpayer cannot be called on indefinitely to add to the resources of particular tracts. These principles have been fully understood in the Central Provinces. The great obstacles to supplying the people with irrigation at the public cost are that they have not learned how to use water to the best advantage, and that they are not willing to pay a fair price for it. In plain language, the question to be put to the people is this:—"Can you pay from 2*s.* 6*d.* to 3*s.* per acre for water for your crops?" and a few years ago the answer would have been an indignant refusal. To persons whose rent-rates were measured in annas the idea of a water-rate running into rupees seemed preposterous. But in these few years there has been a complete change. In 1905 the water-rates assessed on the major works then in operation averaged 9*d.* an acre; in 1910 they had risen to 2*s.* 7*d.*; and while a readiness to pay such a rate over the large areas to be

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watered by the canals may come slowly, there is no doubt that it will come, and there is every hope that the canals will not merely protect the country from famine, but that they will give the State an adequate return on its outlay from public funds and form a lasting monument to the memory of the present chief engineer, under whose supervision they have been constructed or initiated.

The Agricultural Department supplements the work of the engineer by vigorous propaganda, teaching the value of water for irrigation, and how best to use it. In the rice-tracts it has specially concentrated its efforts on this object, and there is every prospect of its success in substituting the superior processes in use elsewhere for the wasteful methods of the apathetic *chamars* of Chattisgarh. It proves by actual demonstration that the cultivator can with care and skill increase the value of his produce by five or six times the amount he pays for irrigation, even in ordinary years. With the work of that Department in other directions time does not permit me to deal, and for the same reason I pass over the success which here, as elsewhere in India, has attended the opening of co-operative banks. If the progress of these institutions continues as it has commenced, not only will a step of which the importance can hardly be over-estimated have been taken in putting the country population in a position to finance themselves, but a valuable training in business habits and co-operation will be given. The village bank bids fair to become a centre of village life, and to restore the old corporate feeling that once animated the best of the rural communities and that threatened to disappear under the disintegrating processes of an individualistic civilisation.

In education the Central Provinces may fairly claim a high rank amongst the Provinces of India. Their village-schools system has been considered by the Director-General of Education sufficiently worthy of imitation to deserve a monograph all to itself; that monograph is one of those rare official publications that are genuinely interesting, and nothing I could say could equal its authoritative and picturesque descriptions. I confine myself, therefore, to noting as an outside observer the prominent part which the village and secondary schools take in the routine of administration. As the official visitor passes from camp to camp, he finds all the village schools on his route *en fête*. If the school-house is far off he may be intercepted on some unfrequented road by the schoolmaster and the village elders, while the scholars are clustered round a table arranged by the wayside. Or, as his train halts for five minutes at a village station, he may be surprised by the strange gyrations and manœuvres of a group of boys drawn up in lines on the platform. On inquiry he learns that they have been marched down from the nearest school to display their proficiency in indigenous physical exercises. There is no doubt that the attention paid to the schools and the practical character of the instruction given, has created a very real interest in them. The proportion of boys at school is higher than in northern India, while female education is, as elsewhere in India, expanding rapidly, and there are now some 30,000 girls in the schools. The change of attitude towards the teaching of girls is one of the many signs of the transformation that is in progress in the East. In his excellent and concise account of the "Peoples and Problems of India," Sir Thomas Holderness says that, "Outside missionary and other circles, there is practically no female education. Popular prejudice against it is firmly entrenched in the institution of caste and early marriage, in the *pardah* system, and in the Oriental view of the mission of women." Ten years ago, or even less, these remarks would have seemed too obviously correct, as regards northern India at least, to attract attention. But they are no longer applicable; they certainly give a wrong impression as regards the Central Provinces. Prejudices are giving way, the tide is turning, and if girls do not stay long enough at school to gain much benefit, they come in numbers that contradict the idea of general opposition. In India, as a whole, the number of girls at school has increased from 385,000 in 1901, to 764,000 in 1910. It has almost doubled in the decade.

The Central Provinces have now long passed the stage at which they could be called backward. In one respect, however, their development still leaves much to be desired. It has been impossible as yet to bring the roads up to the standard of modern requirements. They are being improved, but are still far from being such as the crowded traffic of many parts of the country might legitimately demand. The absence of good trunk roads is in striking contrast to the rest of India. This large area in the centre of the country has not one good through road by which it can be traversed from side to side in any direction. It is not to be inferred that the machine which travels from Pekin to Paris, or from Cairo to Luxor, would be defeated in an attempt to cross the Province, but, as a fact, the motorist from Bombay, on his

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way to Calcutta or Upper India, turns aside and wisely prefers a long detour through Native States. If he crosses the Provincial boundary he will do well on unknown roads to drive warily, lest he fall into the traps, not of the police, but of the impecunious road-makers. It is worth consideration whether the further opening up of the country would not be more quickly effected by good roads and petrol-driven machines, than by tram or railways. Attempts in this direction in the past have failed, but the development of the petrol engine in recent years, and the extent to which it is now utilised for long-distance traffic, suggest that it may help to solve the transport problem in such a country more cheaply, and, in some places, more effectively than the railroad.

If road communications still leave much to be desired, the cause is to be found partly in the great area of difficult country to be provided for, partly in the poverty of the Province. Half a century ago, roads hardly existed, and in the early sixties, at the time of the great cotton boom, pack bullocks had to be largely employed for transport. The various parts of the Province were then almost entirely shut off from trade with each other. In 1862, wheat sold for eighty seers to the rupee in Chattisgarh; forty-four seers at Jabalpur, and twenty-one seers at Nagpur. The construction of railways has now so entirely altered the situation, that it has well been referred to as much the most important fact in the history of the Province. The railways have allowed of the development both of the agricultural and mineral wealth of the country. They have given mobility to labour, and rendered possible the beginnings of organised industry; they have done much to weld the disjointed portions of the Province into a corporate whole. A through line up the Nerbudda valley was completed in the sixties, when also Nagpur was given a connection with Bombay, and some twenty years later a through line to Calcutta gave Chattisgarh an outlet to east and west. The Satpura plateau has, by the enterprise of the Bengal-Nagpur Company, been opened up by a narrow-gauge line which dips down into hitherto undeveloped parts of the Nagpur and Chattisgarh plains. In the north and north-east there are other lines, and when the much-needed railway from Itarsi to Nagpur, which is now under construction, gives direct communication between the districts lying north and south of the Satpuras, the chief needs of the Province will, with one exception, be fairly well satisfied. The one exception is the cotton country west of Nagpur, the wealth and traffic of which would easily support a considerable development of its railway system.

The effect of the opening up of the country on the condition of the people has been far-reaching, and would afford, owing to the diversity of the circumstance, an interesting field for economic study. Here I can only indicate the impressions I myself received. The Province may, with reference to its agricultural products, be roughly divided into four sections, the first of which is the hilly country in the centre of the Province, and in outlying parts elsewhere, where the main crop is one or other of the small millets grown by the people for their own consumption. Here the effect on the people as agriculturists is as yet comparatively slight. They are being brought within reach of commercial influences by the trade in oil-seeds and in forest produce, but the development has only begun. The mineral resources, however, of the country lie mainly in or near these tracts; and their exploitation has already affected, and must affect much more strongly in future, the condition of the people, and give them some guarantee against the precariousness of their crops. Coal is found in many parts of the Province, in fields of great extent, though not up to the present of sufficiently good quality to encourage production on a large scale. It has long been worked in Chanda in the south, and below the hills bordering the Nerbudda —and more recently a new field has been opened in the valley of the Pench River in the Satpuras. The production is still on a small scale, the largest output yet recorded being 238,000 tons, valued at £72,600 in 1909. The extraction of manganese ore began about twelve years ago, and rapidly assumed considerable proportions, the production in 1907 reaching 565,000 tons, valued at a million and a quarter sterling. The bauxite and iron ores still await their commercial development.

The second agricultural section of the Province is the rice area, which is chiefly the country lying south and east of Nagpur, including the Chattisgarh plain. The area under rice amounts to about 7,500 square miles, and the railway has now given a commercial value to the production of this crop. Formerly in Chattisgarh the surplus produce was stored or rotted. Now the railway cannot easily carry the stocks for export. In the busy season the stations are heaped with bags of rice, and telegrams are wildly despatched to the railway officials and to every authority in India, from the Government of India downwards, that can be supposed to bring influence to bear on

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railway administration, complaining of the want of transport. The Chattisgarhi is slow to adapt himself to a changed environment, but it may confidently be predicted that here as elsewhere his character will be altered by the facilities which the railways and irrigation together will afford him of bettering his material condition.

The people of these two tracts offer interesting examples of movements that are partly a striving for higher religious ideals, and partly a very practical struggle for social betterment. The lower classes from time to time revolt against the position assigned to them by the orthodox. They strike against the authority of the Brahmans with weapons usually drawn from the Brahmanical armoury. The Kabirpanthis and Satnamis are weavers and chamars who have so revolted. They demand the abolition of caste and the equality of all men, but place restrictions on themselves that seem meant to secure a higher place eventually in the orthodox caste system. In some cases, for instance, not only is eating of flesh prohibited, but lentils and tomatoes are tabooed on account of their red colour. A more purely practical movement arose amongst the Gonds in one district a few years ago. Reverence for the cow was enjoined, but the movement was mainly a temperance one, and was actively encouraged as such by the authorities. Temperance is so much the established rule in India, that in quoting from the appeal which the leader of this movement made to his tribesmen, it is hardly necessary to add that it applied only to a small section of one tribe. There is a familiar ring about the appeal; it shows how much resemblance there is everywhere in the obstacles to human progress.

"There is one great thing," he said, "which has utterly spoilt us, and it is liquor. So long as we don't drink liquor we live like good persons, and when we get drunk we commit as many mischiefs and faults as possible, and do several evil things, and besides, when we go to the bazaar and refresh ourselves in the liquor shop, we all sit together, husband and wife, and squander money in purchasing liquor, and return home with empty pockets without making any necessary purchases for our livelihood, and thus become penniless in the end. That is why the Gonds are called wild and jungly." This crusade against drink had a remarkable success at the time, and its effect is not likely ever to pass entirely away.

The third agricultural area is that where wheat is the chief crop, the Nerbudda valley and the more fertile parts of the adjoining high lands. A transient wave of prosperity came to this tract a quarter of a century back, the value of land rose rapidly, rents which were then subject to fewer restrictions than now were pushed up, and generally the standard of living reached a level at which it could not be maintained in the lean years that followed. Wheat was then commercially the most important of the exports from the Central Provinces proper, where in 1893 it covered 6,700 square miles of cultivation. Since then it has given way to cotton, *jowar* or other crops, and now the total area occupied by wheat in the whole Province is under 5,000 square miles. The cultivators of this area struck me a few years ago as less sanguine about their prospects than those elsewhere; their thoughts seemed to turn more to the good times of the past.

The prosperity of the cotton-tract, on the other hand, has gone on increasing by leaps and bounds. The cotton country is pre-eminently Berar and the western part of the Nagpur plain, but it is extending round the Satpuras and up the Nerbudda valley. Altogether 6,500 square miles of cultivation were under this crop in 1909–10, nearly a third of the total cotton area of India. No other Province gives an equal area to cotton. No Province except Bombay gives half as much. There have been two periods of great prosperity for the cotton country, the first during the time of the American Civil War, and the second in recent years. During the first, it has been said that the cultivators made the tyres of their cart-wheels of silver; in the last their prosperity has had a more tragic effect, and it has been officially reported that a number of suicides were committed "in a delirium of joy at the extraordinary profits of agriculture."

Much has been said of the desirability of improving the cultivation of cotton in India, with a view to obtaining a longer and finer staple. There is no crop to which the Government of India has given, and is giving, more attention, but the experience of the Central Provinces gives as yet little hope of success in the particular direction desired. On the contrary, the cultivators seem to be discarding the finer for the hardier varieties, and the experiments made tend to confirm the conclusion to which their common-sense has led them, that for the present this course is the most profitable. When a cotton plant is discovered that gives an equal and an equally certain yield of a more valuable fibre, they are shrewd enough to adopt it readily; but they are equally shrewd in not neglecting the substance for the shadow. The markets of India

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are the whole world, and the fibre which is not good enough for England finds a ready sale elsewhere. In 1909–10, the total exports from India of raw cotton were valued at nearly £21,000,000, and of this the United Kingdom took £1,300,000, or about one-sixteenth, Belgium and Germany took between them over £5,000,000 worth; Japan took nearly £8,000,000. It will require very conclusive demonstration of the possibility of growing a long staple fibre to induce the Indian cultivator to risk the loss of his trade with countries where a short staple is in demand. The Agricultural Department has not ceased its efforts to obtain better varieties, but its most promising arrangements are those directed to the immediately practical result of improving the varieties already grown, and above all of providing a supply of good seed for the cultivators.

The cotton-tract is not only the wealthiest but in every way the most advanced in the Province. Here the commercial spirit is most fully developed. There are numerous mills, of which the Empress Mills, at Nagpur, belonging to the Tata family, deserve special mention, both for their size and the excellence of their management. In addition to the large mills, the country is studded with cotton-gins and presses, round which in the cold weather the mounds of cotton glitter in the distance like vast snow heaps. Here, too, there is a great quickening of social and political life, and if the manifestations of the latter are sometimes of a kind to be regretted, the regret is nowhere greater than among the better classes themselves. All this part of the Province shows the influence politically, commercially and socially, of its proximity to Bombay. The following account taken from the Nagpur Gazetteer of the day of a young educated Indian will perhaps bring home more clearly than any formal description the changing conditions which the development of material prosperity, and the progress of education are giving birth to.

"He gets up between four and six, according to the season, and does a little exercise with dumb-bells or Sandow's developer. He then has some tea and goes out for a morning walk, and, coming in before seven, disposes of any work he may have or reads a book. Between nine and ten he bathes and puts on a clean loin-cloth, and . . . goes through his formal morning devotions . . . He will then take his food . . . rice, pulse and vegetables are generally the materials . . . and wheat and *juár* are seldom eaten. Curds are always eaten . . . Among the urban classes tea is drunk with milk and sugar, in cups and saucers of enamel or earthenware. Coffee and cocoa are less popular, but are coming into use . . . In the more advanced community a table-cloth, white or coloured, is spread on the ground and the dishes are placed on it. The people sit round it on stools and take their food from the ground. Tables and chairs are generally kept for writing. Leaf-plates or plantain leaves are still used when a number of guests are invited. After taking his food the clerk will smoke or chew betel-leaf, and then proceed to his office. The practice has lately grown up among the official class of having lunch . . . When he gets home from office about five or six, a man washes his hands and feet, has a little refreshment and plays tennis or goes for a walk. The higher classes of officials now have a club at Nagpur, where tennis, billiards and ping-pong are played. He will come back at 7.30 or 8 and have supper. After this he chews betel-leaf, smokes, and reads the newspaper, or plays on some musical instrument, going to bed about ten."

Conditions are indeed changing rapidly amongst all classes in India, but perhaps the most remarkable of all the changes is one of which we do not take much account in the political and social aspect—the great increase in the demand for labourers, and the consequent improvement in the position of the labourer. In the Central Provinces many circumstances have combined to enhance the value of labour. It is wanted for the mills, and the cotton presses, the mines and quarries, for the railways and irrigation works, apart from the ordinary demands of seed-time and harvest. It is difficult to state the rise of wages in figures, because agricultural wages have always been largely paid at customary rates in kind, but that the labourer can command far higher remuneration than before is a patent fact that is by no means always welcome to their old employers.

"*Malguzars*," says one report, "are often envious of the prosperity of their tenants, but *malguzar* and tenant alike look with disgust on the blatant prosperity of the labourer." It is often said that the great need of India is expansion of its industries so as to secure diversity of employment. In the Central Provinces, I believe the expansion to be proceeding as rapidly as is desirable; too great and too sudden a change in economic conditions is to be deprecated. There is no longer a surplus population dependent on emigration to Assam or the colonies for a livelihood, and the deserted sheds of the coolie recruiters tell of the disappearance of a once remunerative occupation. The problem of famine administration has assumed new forms, and drought, except when very serious, may lose much of its terror. The depressed classes are bestirring themselves, and the higher classes are beginning to take a new interest in their welfare. Agriculturists bemoan the increased cost of

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cultivation, but they have the compensation of higher prices. With more reason the recipients of fixed salaries complain of the difficulty of maintaining their standard of living, and the State is faced with the possibility of a large increase in the cost of its establishments. The change is not confined to common unskilled labour. There is a much greater demand for the skilled mechanic, and the next generation of Indian workmen is likely to develop a much higher degree of mechanical skill than its predecessors. The effect of the training in technical schools, and still more of the training in the great workshops on the railways, and at such places as the gun-carriage factory in Jabalpur, is only now beginning to make itself felt, but it means the creation of a race of skilled artisans with all the independence of that class. The rapid emergence of the ordinary labourer from a condition that gave him a bare subsistence to one of comparative comfort, or even of comparative affluence, and from a state almost of servitude to one of freedom, can hardly fail to have a profound effect on the constitution and character of Indian society.

In the past the great internal problems of India, apart from the primary question of the maintenance of law and order, have been mainly those connected with the land, the method of its tenure, the equitable adjustment of proprietary and cultivating rights, and the collection of a fair revenue for the State in such manner as to be least burdensome to industry and to the progress of agricultural improvement. These problems have lost none of their absolute importance, nor can they ever do so in a country the dominant factor of whose welfare must always lie in its agriculture. But their relative importance has diminished; they no longer overshadow other questions to the same extent as before. Owing to the rise in prices the burden of the revenue has been lightened, apart from all the advances made in recent years, and especially during the Viceroyalty of Lord Curzon towards a less rigid and more liberal system of collection. The revenue weighs less heavily on the people, and its collection gives less trouble to the authorities. At the same time the opportunities for making a livelihood otherwise than by the land are multiplying rapidly, and new openings are presenting themselves, not to the labourers alone, to whom reference has already been made, but to the higher classes as well. Formerly Government service and the law appealed to the educated youth, almost to the xclusion of other methods of livelihood; now the possibility of success in other careers is widening his outlook, and giving him larger views as to the measures necessary to promote the development of his country. In the Central Provinces the educated classes have keen political and commercial instincts, and it is interesting to note how their public men apply themselves to questions of definite practical importance — sanitation, technical education, the encouragement of industries, and the development of irrigation. Their representatives on the enlarged Imperial Legislative Council have from the beginning borne an active share in the work of that body. They have not merely taken their full part in the discussion of matters of Imperial interest, but have kept provincial affairs in evidence with a persistency that might almost suggest a diplomatic design to expedite the formation of a Provincial Council of their own to which such local matters might be transferred. The same active spirit animates them in the sphere of commerce and industry. The cotton trade has shown the profits to be made in business, and lawyers and landholders join in organising or financing manufactories or presses, or in following the lead given by the European in the exploitation of the country's mineral resources, and so finding employment in prospecting work or remunerative investments in the maganese quarries. The people are thus preparing themselves to play their part in the future developments that must come; and it is satisfactory that this should be so, as their interests must tend to encourage the promotion of local industries for dealing with the mineral ores in which their country is so rich.

Further signs of adaptability to modern conditions, and readiness to take advantage of new openings, may be seen in the establishment of independent medical practitioners in the towns and even in the large villages, and in the acceptance by educated men of posts in the manufactories. At the Empress Mills, Sir Bezonji Mehta gives the B.A. a welcome which, to judge from recent correspondence in the *Times*, the graduate does not always receive in similar cases in this country. It is time that we revised our ideas of the unchanging East. India at least is changing rapidly, and recent political measures have given the people a keener interest in its development, and a stronger determination to play their part in influencing that development on lines of their own. There is a new consciousness of power, which will react outside the merely political sphere and quicken the pulse

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of the country in all its movements. There is every sign that the Central Provinces will not be behindhand in responding to the altered conditions. That they may share to the full in the times of peace and prosperity that we hope and believe are in store for the whole country, must be the wish of everyone who has ever come under the charm of that picturesque Province and its interesting people.

DISCUSSION.

The Chairman (Lord MacDonnell) said the author had commenced his paper with an apology for bringing forward an account of his old charge, which, he said, would probably not interest his listeners. He (the Chairman) thought the audience would agree with him in saying that the paper had been most interesting. To the stranger it gave an admirable idea of the multiform life of the Central Provinces, and he thought to all Central Provinces officers it might almost be called an index—an index of the most interesting book that it had ever been his lot to read. For he (the Chairman), too, was one of Sir John Miller's predecessors as Chief Commissioner of the Central Provinces; and, as the author had developed his theme, his mind had gone back to the years that he had spent in the Central Provinces. He could bring back to himself concrete instances of all the remarks in the paper, especially those dealing with the picturesqueness of the country, and of the free and open life which it was the privilege of all Central Provinces officers to lead. The author had not mentioned the camp life which every Central Provinces officer underwent for many months in the year, or the facilities for sport which were open to him, and which in no other part of India could he enjoy in the same perfection. An incident which had occurred in his own experience had come to his mind as the paper was being read —the first time he ever went on a great hunting expedition under the charge of the then Inspector-General of Forests, or the local forest officer in the Central Provinces, one of the most accomplished shikaris that any Province in India could produce. Those were days when a young officer in the Central Provinces came in contact with men who did not count their tigers by scores but by as many days as there were in the year. The gentleman he was referring to, Mr. Thompson, in taking him out on his first tiger-shooting expedition, had told him that in his early days he had been deputed for the purpose of clearing a particular tract of country of tigers, and before he left it he had killed a tiger for every day in the year. It was an education to be with Mr. Thompson, not only for the experience that he gave of the shikari, but for his extraordinary knowledge of jungle life and his perfect understanding especially of bird life and the forests. There was nothing that gentleman did not know, and, sitting in the evening in their tents, every voice of the jungle carried to him a particular meaning. He (the Chairman) should have taken some exception to what the author had said in regard to ancient remains in the Central Provinces, but any criticism which he was disposed to make upon that point had been completely answered by the excellent slides which had been thrown on the screen. He himself was greatly struck with the solidity of the ancient structures, and when it was remembered that those structures had come down from the Gond times, one would be able to see that even in those old days, before the Central Provinces were subjected to any outside influence, there was a great school of architecture there—more remarkable for its solidity, perhaps, than for its grace of execution. In the Central Provinces, as the author had shown, there were not only ancient Hindu monuments, but also the indigenous and aboriginal monuments which he might call the Gond type, overlaid by the Mohammedan monuments which were found in Burhanpur. The remarkable thing was the great complexity of the races which were found everywhere in the Provinces. He supposed in the early days of the history of India those highlands of Central India were the refuge of the aboriginal tribes, who had remained to the present time perfectly unaltered and uninfluenced by the civilised life which surrounded them on all sides; they still led the jungle life which they must have led for 2,000 years. They were the most perfect and fearless beaters for game that were to be found in any part of the world. In regard to what the author had said about forests, he quite agreed that the Central Provinces administration had been always most careful in its dealings with the people in connection with forests. The population was very sparse, and there was no necessity for Government to interfere and deprive the people of the custom, which they had enjoyed for so many years, of enjoying forest produce. It was impossible, owing to the absence of means of communication, that it should be otherwise. Until the Central Provinces were pierced, as they were not at present, with the means of communication by which forest produce might be extracted and made an article of commercial value, it was best to allow the people to enjoy their ancient rights. In regard to settlements which the author had mentioned, one thing had to be borne in mind, namely, that the rates of revenue which were collected by the Government in India could not be compared with each other acre by acre. The incidence per acre in one Province could not possibly be compared with the incidence per acre in another Province. For instance, taking the two cases of Berar and the Central Provinces, in Berar he understood from the paper that the ordinary rate of revenue was at 2*s*. per acre, while in the Central Provinces it was only 8*d*. or 9*d*. The explanation was that in Berar the crops were so much more valuable than they were in the Central Provinces. Berar was the most productive cotton country in India, producing cotton of excellent character, and consequently

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fetching a far higher price in the market than did the millets and the other inferior grains which were produced in the Central Provinces. Consequently the cultivator in Berar could afford to pay to the Government a larger revenue, though not a proportionately larger revenue, having regard to the value of the crop. The question of land revenue settlements was a very burning question in India some time ago, and a charge was brought against the British Government for being excessive and exacting in its demands. That question was very wisely made the subject of a most careful inquiry by Lord Curzon when he was Viceroy, and a resolution was prepared in which the revenue systems in force in every part of India were carefully analysed and compared with each other. He (the Chairman) had left India when that resolution appeared, but he thought a more complete and perfect answer to the charge of excessive exaction on the part of the British Government on the natives of India could not have been made. He himself believed—and he had had, before he left India, opportunities of forming a judgment on the point in connection with certain inquiries made in relation to famine—that there was no country in the world in which the claims upon the cultivator of the soil were apportioned or assessed with more care for the interest of the cultivator than was the case in India, especially in the British portions of India. It had been his province to compare the rates assessed in the British districts with those assessed in the adjacent native districts, and in every case in which a comparison was possible it was in favour of the British system. The author had made some remarks in regard to famines, and the sufferings which the people had had to bear during the last five years of the last century. That was the only point on which he at all experienced a feeling of disagreement with the paper. The author said that each famine brought with it its own questions and its own difficulties. Like all other questions, when the ground principle of famine relief was grasped, the difficulties which any particular famine presented to the administrator were no longer of any great magnitude. The essential principles of famine relief were explained in language of which he always thought with the utmost respect by that great Commission which sat in India and reported in the year 1880. It was presided over by a most distinguished officer, Sir Richard Strachey, and the Secretary of the Commission was that most eminent Indian officer, Sir Charles Elliott. They laid down principles which he (the Chairman), who had had some dealings with famine, believed were the last words to be said in regard to famine relief. They said: "The great object of saving life and giving protection from extreme suffering may not only be as well secured, but in fact will be far better secured, if proper care be taken to prevent the abuse and demoralisation which all experience shows to be the consequence of ill-directed and excessive distribution of charitable relief." He had heard with great satisfaction Sir John Miller's words in regard to Sir Reginald Craddock's treatment of the last Central Provinces famine. He had not heard of it before, but he had expected that Sir Reginald Craddock would take that view of famine relief—that the duty of the Famine Administrator was not to give charitable relief where it could possibly be avoided, but to enable the people to work out their own salvation by affording them the means of earning a livelihood. When in the Central Provinces he (the Chairman) had the pleasure of knowing Sir Reginald Craddock and had formed the highest opinion of him, and he was glad to see that in dealing with famine that gentleman took the only true and proper method possible, a method which was first advocated and proclaimed by the Famine Commission of 1880. Sir John Miller had also referred to the changes that had come over the Central Provinces—changes so great in some directions that he (the Chairman) could scarcely keep pace with the swiftness with which they had been effected. He spoke of the possibility of there being a Council founded in the Central Provinces. He (the Chairman) thought that was quite possible. It was the direction Indian administration was now taking; but he trusted that the time was far distant when to a Legislative Council would be added the Executive Council which was now being created in other Provinces. The Central Provinces were still peopled by a homely race, and although Bombay was near, and the educated natives of the Central Provinces were imitating Bombay in all that appertained to commercial advancement, the vast mass of the people were still in a very backward stage of national development; and they naturally, as in other Provinces—and he hoped it would long continue to be so—looked to the district officer and the officials of Government as their best advisers and protectors in difficulty and adversity. We were living very fast in these times, but it might be possible to live too fast in matters of that description. The prestige of the English officer among the people of India still lived, and, although it was quite right and proper that to the educated natives of India larger spheres of activity and higher employment should be given, England must be prepared, if that policy was carried far, for a less efficient Government in India than she had hitherto demanded. She must remember that Englishmen—from the training they received in India, when brought face to face with conditions of life calling for self-reliance, resolution, readiness to meet emergencies as they arose, determination to maintain law and order at all costs, and the firm resolve to administer the law with perfect impartiality to all people—had imprinted on the administration the character which England had up to the present demanded. If such Englishmen became scarce, the same resolute action, the same freedom from local ties, the same degree of impartiality could not be maintained in the administration. The men who would replace them would themselves be resolved and determined to act up to the lessons which they had learnt from their

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English colleagues, but there would not be for many years to come that freedom from influences and that impartiality which had always been the mark of the Englishman in dealing with the natives of India.

Sir Benjamin Robertson, K.C.S.I., C.I.E., said he had been acquainted with the Central Provinces for nearly twenty years, and he was about to return to India in a month or two to take over the administration of that part of the country, where both the life and the people were extremely fascinating. He would like to add his voice to the testimony which the author gave as to the superficial nature of what might be called the lack of polish which was noticeable amongst some of the people, particularly in the south of the Province. As an example of what an excellent stamp of people the Province contained, he could not do better than quote the case of the Mahratta patel of Berar. He did not think there could be found anywhere in India a finer specimen of the Indian cultivator. If he (the speaker) were to specify the chief points which covered the time of his acquaintance with the Central Provinces, he should perhaps refer to the wonderful recovery from the famines which marked the close of the last century and the beginning of industrial development which had occurred since the present century began. He noticed his friend Mr. Manson in the room, and he would like to mention in connection with his name the remarkable progress which had been made in parts of the country through the extensions of the Bengal-Nagpur Railway. When he (the speaker) was under the Right Honourable Chairman, he was the Deputy Commissioner of a small district named Balaghat. It was about thirty miles from the railway, by a road on which there were two unbridged rivers, and at that time the telegraph line had only just been extended, by the Chairman's efforts, to the headquarters of the district. That was the state of affairs in 1892. Twelve years later he happened again to visit the place when manganese mining had been undertaken. The railway had by that time been built, and, as he was returning in the afternoon to the main line, he was told if he desired to do the journey more quickly than by the ordinary train he might catch the "Manganese Special." That showed what progress had been made in twelve years. Progress had been the watchword of the Province, and he hoped when he went out there it would still continue to be so. In conclusion, he begged to propose a vote of thanks to the author for his interesting paper.

Sir James Wilson, K.C.S.I., in seconding the motion, said all must have enjoyed the very clear and interesting account which the author had given of the fascinating Central Provinces—in fact it had made him (the speaker) almost wish that instead of being sent to the Punjab he had been sent there. One point in connection with the administration of the Central Provinces—which perhaps did not apply to other Provinces in India —was that they had had the advantage of having a succession of very able rulers chosen from outside. He did not know what the people of the Central Provinces thought about it, but in the Punjab they would not like to have all those outside governors, however able they might be. He hoped the tradition of having Chief Commissioners from outside was now broken as, although he knew the Central Provinces had derived much benefit from the able men who had successively ruled them, there were great advantages in having a man to govern a Province who knew its people and whom the people knew. Some time ago Sir Denzil Ibbetson, who was then a member of the Government of India, had consulted him about what should be done when Sir John Miller in the ordinary course would move on. Sir Denzil, who had himself been Chief Commissioner, said that he felt very strongly that it was rather hard that the Central Provinces should almost always be governed by men from outside, however good they might be, and that it was time, if it was possible to find a man inside the Provinces who was fit to be Chief Commissioner, to appoint that man. It was in consequence of that opinion, that ultimately Sir Reginald Craddock was chosen to be Chief Commissioner, and he thought the results proved that Sir Denzil Ibbetson was perfectly right. Under Sir Reginald Craddock's vigorous administration the Central Provinces had advanced in every possible way. It was also a matter for congratulation that another Central Provinces man had been found in Sir Benjamin Robertson, under whose rule the Provinces would no doubt make a further advance. In addition to seconding the vote of thanks to the author of the paper, he desired, on behalf of the Indian Committee, to thank Lord MacDonnell for so kindly taking the chair that afternoon. Lord MacDonnell had told them something about his own connection with the question of famine in India. He (the speaker) had had the privilege of helping to work out the recommendations of the Commission over which Lord MacDonnell had so ably presided, and he knew what an enormous benefit that Commission had conferred upon the peasantry of India by its careful investigation of famine problems and the wise advice it had given, which had been adopted by all the local Governments in India.

The vote of thanks was then put and carried unanimously.

Sir John Miller, in acknowledging the vote, said he desired to express his personal gratitude to Lord MacDonnell for having, amidst all his business and the very heavy affairs which were devolving upon him at present, found time to preside that afternoon. He further wanted to say that it was not only his own appreciation of Lord MacDonnell's kindness, but he felt sure that if he could speak for the Central Provinces they would all feel pleased

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to know that the most distinguished of their former Chief Commissioners had found time to attend and hear a paper on the Provinces.

The Chairman said it had been a great pleasure to him to attend that afternoon. He had been more than repaid by the courtesy with which the audience had listened to him, and the pleasure which he had experienced in listening to his old friend Sir John Miller's paper.

TWENTIETH ORDINARY MEETING.

Wednesday, May 8th, 1912; Colonel Sir Edouard Percy C. Girouard, R.E., K.C.M.G., D.S.O., Governor of Northern Nigeria (1908–9), and of the East African Protectorate (1909–12), in the chair.

The following candidates were proposed for election as members of the Society:—

Prashad, Rai Bahadur Ashtabhuja, Bansi Ditt, Basti, United Provinces, India.

Reindorf, Christian J., Accra, Gold Coast Colony, West Africa.

The following candidates were balloted for and duly elected members of the Society:—

Halford, George, A.R.C.A., 11, Foden-road, Walsall.

Japp, Henry, 507, Fifth-avenue, New York City, U.S.A.

The Chairman, in introducing the author, said that Mr. Morel needed no introduction to a British audience, or indeed any audience. His devotion to African interests, his single-mindedness in contest, and his achievements for African advancement, were very well known to all. Mr. Morel had temporarily, for that night at all events, abandoned one sphere of action for another, and the speaker was sure that all who lived in Nigeria, or who had the interests of that country at heart, would welcome his remarks as a witness or critic of what had been done there. Mr. Morel had written a book on the subject even before he visited West Africa. People who visited the colonies were frequently possessed of an insatiable desire to write a book on the subject, even on short acquaintance. It became a form of mania in some instances, in others a disease, one which apparently had not been investigated by the schools of tropical medicine, unfortunately for the Governments who had to endure them. He would say about Mr. Morel's book that it was surprisingly good. It might have inaccuracies, but on the whole it was read with very considerable interest in West Africa. In 1909 Mr. Morel had had the opportunity to visit West Africa, particularly the Nigerias. As a result of that visit, a series of brilliant articles appeared in the public press, bearing upon the progress, the past, and the future of the two Nigerias. These articles were expanded into a book which certainly was to-day almost a standard treatise upon the mental, moral, and manual work which had been accomplished in Nigeria, particularly within the last ten years. The speaker had himself spent two of the happiest years of his official life in Northern Nigeria, but Mr. Morel would have more up-to-date information to give, and he (the Chairman) would content himself with saying that it was a country of a vast and surprising interest. It was almost like stepping into the "Arabian Nights," after leaving the coast, to go into the old Mohammedan empires, which ceased in 1493, although their laws were continued in the rest of the Mohammedan world down to the present time, with the treasures, universities, and all the panoply of the government of the Middle Ages. It had been the speaker's duty to carry on the work of a man who had devoted six years of his life to creating Northern Nigeria, adding to the dominions of the Crown 250,000 square miles and 10,000,000 people. He was loath to give up his task, and had, in fact, to be forced from it; and while the speaker could quite understand that any Governor who had the honour of ruling in Nigeria for his Majesty should feel such sentiments, none could possibly leave the country with the same feelings as the founder of it had. It was borne in upon the speaker all the more clearly that his primary duty was to carry out a policy so successfully inaugurated by his predecessor. A very short acquaintance with the country itself, and with the Civil Service, which had grown up around the Governor, had convinced him that during the time he held the Governorship it would be his duty to adopt the views of his predecessor. Certain details it was necessary to change, but in essentials nothing was altered. In such a country changes came up from day to day, but in all those changes he believed that the spirit if not the letter of a policy which was inaugurated by his predecessor was followed from year to year. He was glad to know that his successor had worked upon the same lines. It would be his principal pleasure in looking back upon his work in Nigeria —and he thought he could also speak for Sir Henry Hesketh Bell, his successor—if, when Sir Frederick Lugard returned to Nigeria he saw that, on the foundations which he had laid so well, an edifice had been erected to which he would find no objection, and to which it would only be necessary to add wings to create almost a celestial structure. All Nigerians were especially glad and satisfied that the creator of Northern Nigeria, as it was known to-day, had been chosen by his Majesty to unite the two Protectorates. The work was a great one, and he was quite sure that the genius which created Northern Nigeria would be able to unite the two colonies into one homogeneous whole. The speaker was sure that the great, even the paramount, interests of Southern Nigeria would not be forgotten in such hands; and that the work carried out for many years by Sir Walter Egerton, as collaborator with Sir Frederick Lugard and himself, would be duly appreciated, and utilised to

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mould a country which would be an honour to the Crown. The one factor necessary, the one upon which Lugard founded his policy—and the speaker was readily able to agree with that—was the utilisation of the native populations in their government; utilisation of the genius which they undoubtedly possessed—some in a marked degree—for their benefit in the future. It was a policy which aimed at the development of what he might call British African nationalism; it was a kind of slow-setting cement, to be applied to a corner stone. It was not possible to hurl a people from the eighth to the twentieth century in twenty months, or twenty years. If, however, gradual development and evolution of the people were allowed, he felt confident that stable government would be established in British West Africa.

The paper read was—

BRITISH RULE IN NIGERIA.

By E. D. Morel.

On July 21st, 1796, for the first time in the history of the world, a European gazed upon the waters of the Niger. Unutterably weary, as weary as the wretched beast he alternately rode and drove before him, half starved, racked with fever, with no better protection from the sun's rays than an old top hat—of all awful headgear to travel with in Africa—in the crown of which he carried his notes, wearing a much frayed blue fustian coat originally ornamented with gilt buttons, with the hair almost removed from one side of his head owing to the interested attentions of a native friend, who thought European hair made good medicine, and had helped himself freely, the pioneer of European exploration on the Niger beheld, and in beholding solved, in part at least, the mystery which had puzzled the western world for centuries. He was, of course, a Scotsman—and his name was Mungo Park. The Niger, he saw, flowed eastwards, but where? Into the Congo, into the Nile, into the ocean, or did it lose itself among swamps? Six years later Park again set out to complete the reading of the riddle. For 1,500 miles he followed the course of the great river, came to shipwreck at the rapids of Bussa and perished—exactly how has never been ascertained. He perished, but he had pointed the way his countrymen were to tread. To-day, thanks in the first place to the enterprise of our explorers, Richard Lander, Denham and Clapperton, Joseph Thomson, and to the enterprise of our merchant-statesmen, Macgregor Laird and Sir George Goldie; and, in the second place, to the activity and genius of Sir Frederick Lugard, British rule extends over a vast portion, and the most fertile portion, of the countries drained by the Niger and its affluents. In the two Protectorates of Northern and Southern Nigeria—soon, a most desirable consummation, to be amalgamated or federated under the Governorship of Sir Frederick Lugard—we have to-day a dependency which is not merely the most considerable and wealthiest of all our tropical dependencies, India of course excepted, embracing as it does an area of 332,960 square miles, and thus equal in size to Germany, with Italy and Holland thrown in; but one which, from several points of view, is replete with administrative and other problems of quite exceptional interest.

There is Nigeria on the map—still a closed book to the majority of the public, but big with future possibilities; a country of which more and more will be heard with every year that passes. I thought it well to have it permanently on view during the paper, not assuredly because I suspect the intelligence of my audience to be on a par with that of the lady who, when she heard Nigeria mentioned at a tea-party, remarked that it was, indeed, a beautiful creeper—confusing it doubtless with wisteria; but because it may help you, and me too, as we go along. I confess to some little trepidation at my boldness in talking to you about Nigeria under the eagle eye of our Chairman, who has been supremely responsible for the government of five-sixths of this country—to its lasting good—and whose dislike of inaccuracy in statement is known to be of the fiercest possible character. Many years of close study of its history and conditions from this end, a recent journey thereto, on behalf of the *Times* and the *Manchester Guardian*, and a very lively interest in its peoples and its problems—to these, however, I can at least lay claim. Most of you are old enough to remember that we had formidable rivals to a portion, at least, of Nigeria in the French. That was the *pre-entente* period, and a very lively period it was. It was the patriotic thing to do in those days to wax tremendously excited over places and tribes of which one had never heard previously. I recall an incident in the editorial sanctum of a highly patriotic newspaper, about a town of no particular importance rejoicing in the name of Nikki. I called in one evening—not at Nikki, but at the editorial sanctum—and found the editor poring over West African maps and metaphorically tearing his hair. By way of greeting, he burst out: "Where is this

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Nikki, anyhow? I'll be shot if I can find it! Some God-forsaken hole in an African swamp; and yet, for all the fuss they are making over it, it might be the headquarters of old Nick himself." I found it, and, much mollified, he capped his previous performance by remarking that I had turned up in the nick of time.

And now to more substantial diet.

The word Nigeria embraces a region which offers the most diverse and, indeed, startling variations of scenery and human type. That no doubt, in part explains the fascination it exercises over those whom fate leads thither. I will first speak to you of the south. The greater portion of the southern region is covered with dense forest and bush, with an outer fringe of mangrove swamp, which really represents, I think, the steady encroachment of the land upon the sea. Beyond the forest belt the country gradually breaks up into wooded slopes, savannahs, and park-like areas. In the western province, however, the land, though forested, is more open. Man has here destroyed the forests to some extent for his needs, but in many respects improvidently, and a busy Forestry Department is endeavouring to arrest further destruction and to regulate the usage and exploitation of forest wealth. Through this forest and swamp the great river, after its journey of 2,250 miles across the continent from west to east, passes on its way to the sea, bifurcating just below Abo into the Forcados and the Nun, and spreading into a fan-shaped maze of creeks, which reduce the whole country to a series of islands of every shape and size. That is the delta. This deltaic region is indescribably impressive; so infinite; so silent; seemingly, at first sight, so tenantless of human life; in parts, so melancholy and uniform; in others, so beautiful. It resembles some primeval world in which uncouth monsters, such as Professor Challenger's creator is telling us about in the *Strand Magazine* just now, ought by rights to put in an appearance. At first, as you enter it, there is nothing but mangroves as far as the eye can reach on every side, mangroves raising their skeleton-like roots from the mud, the home of many curious and repulsive forms of fish and insect life. But gradually, as you make your way inland, and the banks solidify into firmer ground, the vegetable life becomes increasingly varied. Palms, bananas, ferns, and occasionally the grey upstanding bole of the silk-cotton tree appear, to be succeeded in turn by dense forest growth, interlaced with a net-work of giant creepers. The slide gives you an idea of the Nigerian forest. It is hot, very hot and moist inside, like a much-heated greenhouse; and, to the lover of nature, full of things lovely to look upon—birds, butterflies and flowers, strange and gorgeous. But full, too, of ants and thorns and fierce poisonous plants.

This region is one of the wealthiest in tropical products in the world. Once you come to the alluvial soil it will grow almost anything. It abounds in valuable timber, mahoganies, walnut, satin, rose and dye woods; in gums, kolas, fibres and numerous oil-bearing plants of value. Its future as a cocoa producer will almost certainly be considerable. Cotton it will never grow, I think, in appreciable quantities. But above all it is renowned as the natural home of that most beneficent of trees to man—the oil palm of commerce, the most valuable commercial asset of West Africa, which, judging from its fertility, must be absolutely inexhaustible.

Here you see casks full of palm oil being shipped on board a steamer for Europe, where it is used chiefly in the manufacture of soap and candles. The oil expressed from the kernel is now used for edible purposes, being a constituent of margarine. The fruit of the oil palm plays an indispensable part in native social economy, and any attempt to restrict the free use of it by the native, besides being false policy, would defeat itself. It is used by the native as a diet, a beverage, for lighting, cooking, soap-making, as an ointment, for medicinal purposes, and so on. Its leaves and branches serve for roofing material, clothing, the manufacture of fishing-nets, baskets, as fuel, and for many other purposes. In addition to all its domestic uses, the fruit of the oil palm forms the paramount national industry of the south for export purposes, and gives employment to hundreds and thousands of natives—men, women and children. Nearly five millions sterling worth of palm oil and palm kernels were shipped from Southern Nigeria last year, and the kernel trade is but in its infancy. And the output of that labour—which, bear in mind, is free labour in the fullest sense of the term—by these Nigerian producers gives employment to tens of thousands of European wage-earners: a factor in Afro-European relationship which, were it fully appreciated at home, might tend to modify some curious ideas which appear to be prevalent as to the idleness of the West African native, and tend also to increase public interest in the country.

So much, but a brief glance indeed, at

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Southern Nigeria's vegetable resources. What of the Southern Nigerian himself, without whose mighty muscles, and without whose willingness to use them, all this natural wealth would be lost to the world's industries? In the central and eastern provinces nature deals hardly with man. For half the year the best part of the country is under water. Think what that means for the inadequately sheltered human being who lives in it. Nature is very terrifying in the Nigerian forest region, and mortality —infant mortality especially—is very heavy. Of those that survive, it may be truly said that it is the survival of the fittest. A luxuriant vegetation fights for every inch of tenure with man; tornadoes sweep shrieking through the sombre shades; torrential rains convert the narrow paths connecting one village with another, or leading from the village to the nearest creek, into a raging torrent. Heaven's artillery exercises its fullest powers. Man fights for his life against nature, against disease, and he fights the spirit world, which it is small wonder he should have evolved from his inner consciousness in the midst of that terrific natural environment—a spirit world full of terrors and needing much propitiation. And that fight is, perhaps, the hardest of all, for it is incessant, not leaving man even in his sleep, for then his dream-soul goes a-wandering, and gets into all kinds of scrapes. I don't know whether you will share my view when I express the opinion that it is little short of miraculous that under such circumstances, cut off from the outer world by sea on the one side, by dense forests and human enemies on the other, the Southern Nigerian should not have remained wholly stagnant, the lowest of the low in the scale of humanity. The thing which has saved him has been the stimulating influence of trade. A born trader, he trades from village to village. He has stated market days—regular markets, sometimes at very long distances, which he visits periodically. The whole population trades in the commodities of the country. And when we superior Europeans first appeared in the country, and asked the Nigerian to trade in his own kith and kin, he raised not the least objection, not having reached our then level of sanctity for human life—when covered with a white skin. Now we ask him for his palm oil, his rubber, and his gums, and he is just as pleased to trade with us in those. And he is a keen bargainer— as keen and as quick as any European, as the Europeans who trade with him will tell you. But although successful bartering requires a considerable amount of intelligence, the Southern Nigerian has more in him than that.

Here is a slide which will be more interesting to you when I explain it. It is part of a native rubber plantation outside Benin City, and it tells a wonderful story—a story of what the Southern Nigerian is capable of under a just and common-sense administration. Fifteen years ago Benin City was the centre of a priestly theocracy, of a distinctly unpleasant type. The capital earned and merited the title of the City of Blood. They did not sacrifice as many people proportionately as we find it necessary to put into lunatic asylums or prisons, perhaps, but still they sacrificed a good many, and Benin was not a particularly pleasant country to live in. To-day it is one of the most peaceable districts in the Protectorate, inhabited by some 150,000 enterprising and intelligent people with a keen eye to business. Some years ago it was suggested to the Bini people by the Forestry Department, the value of whose labours not only in an economic but also in a political sense it would be difficult to exaggerate, that if they went in for making rubber plantations they would by and by reap a profit. The Binis believed in the Forestry officer who told them that, and they took the matter up. The Department supplied the seeds, gave advice, trained a few natives in the art and sent them round the villages. At the present moment no fewer than 700 Bini villages possess their own rubber plantations, which, of course, belong to the community on the basis of the native social system. They are increasing yearly, and other tribes are following the example. In the Bini country alone there are over one million and a quarter trees whose present estimated value is £165,000. Many of the trees are now tapable. The plantations have been kept up entirely by the natives themselves, who are now learning to tap scientifically. The Department undertakes to dispose of the rubber for the communities, which ensures their getting the best price going. So gratified are the Binis at the result that when, a little time ago, tapping operations began and the proceeds began to roll in, the chiefs and villagers insisted that the Administration should keep a larger share of the profit than the modest royalty it had reserved for itself. They insisted that the Administration should take one-third, and, despite the Governor's objections, would consent to no other arrangement, which has now

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been embodied into law. That is a true story which speaks volumes for the Administration and for the Bini, and when you are told that the African native is fit for no other *rôle* than that of hewer of wood and drawer of water for the white man, I venture to hope you will remember it.

A word on the western province before we go north together. This is the home of the Yoruba people, and Lagos, situate on an island, is the present capital of Southern Nigeria, a wonderfully cosmopolitan and up-to-date place, boasting many fine public buildings and numerous adjuncts of civilisation, from hospitals and engineering shops to a bacteriological institute and a race-course; but, in my humble opinion, already much congested and not an ideal site for the capital of the united Nigerias. Its streets are a picturesque sight, thronged with a busy, gaily-dressed crowd, and you will meet on its outskirts native traders from as far north as Sokoto. It is cursed with a bar, which the retiring Governor, Sir Walter Egerton, one of the most active and hard-working officers who has ever held supreme control in West Africa, has been making successful efforts to remove by throwing out a couple of moles on either side of the harbour, a gigantic work which, when completed, will make of Lagos the Bombay of West Africa. This is a country of great native cities scattered about the 80,000 miles of hinterland. Nowhere in native Africa are there such numerous and such large human agglomerations—a couple, Ibadan and Abeokuta, possessing well over 100,000 inhabitants, while two or three dozen others have between 40,000 and 8,000 each. Both for their qualities and defects the Yorubas are a most interesting people. Apt traders and farmers, they possess considerable intellectual qualities. Unhappily, and speaking generally of course, the system of education we have introduced among them—a thing of shreds and patches, ill thought-out, or, rather, not thought out at all—is having the tendency to break up their native forms of government, and to produce a political instability with undesirable results. These problems have been somewhat neglected, and will require both firm and tactful handling. A people of great promise, one realises when one moves amongst them—almost as much, indeed, as in the north—the stupidity of the cackle about idle Africans. Here is a picture of a native market in Yoruba land. Scores of such huge markets are to be met with all over the country—as busy a scene, I imagine, as you could find in any part of the world.

There are two ways of reaching the uplands of the north. By the railway from Lagos to Jebba, where you cross in a steamer pending the completion of the bridge across the Niger; to Zungeru, the capital of the Northern Protectorate; and so to Minna, where this line, for which the Southern Nigerian Government is responsible, joins the line from Baro to Kano, built by the Northern Nigerian Government. At least, you can do that now; but you could not when I was in the country eighteen months ago. That is one route. The other route is by boat up the great river itself to Baro, the starting-point of the Kano line. I will ask you to follow me up the river. We shall enter the Forcados branch of the Niger, work our way in to Warri, a trading station of some importance and an administrative centre, through narrow, serpentine creeks of peculiar beauty, whose deep green waters reflect the nodding palms above them, into the main stream below Abo. Up the river for 400 miles, in ten days' steaming, crowded with interest and ever-varying scenes. For the first few days the banks on either side are densely wooded, abounding in cocoanut and oil palms. Fishing villages and canoes are numerous. Here is a magnificent specimen of a Nigerian canoe-man—perfectly proportioned as a Greek statue. Round the villages of neatly-thatched huts are clearings, bright with the tender green of the banana or young maize. The bird fraternity is much in evidence—in the shape of blue and white and black kingfishers, ibises, cranes, marabous, egrets, spur-winged geese, crown birds, and so on. Now and again a hippopotamus will raise his dark head from the waters—then silently disappear. On the sand banks, which are frequent, ever shifting, and a considerable obstacle to navigation, you will occasionally see a crocodile basking in the sun. The sun beats down shrewdly, and it is very hot. You almost lose the sense of time during these reposeful days, gliding onwards on the bosom of the great river. The bustle and stir of European life seem very remote as your little paddle-boat churns its way onwards day after day, inducing a sense of dreamy calm. When the sun goes down, dyeing the waters with glorious hues, the insect world, which, indeed, has not been conspicuously dormant throughout the day, wakes into full activity. Tiny gems of emerald light float towards you from the shore—fire-flies, and exquisite they

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are. Other visitants are not so pleasant, and if the lamp is anywhere in the vicinity, the cloth which is being laid for "chop" will soon be literally black with flies of every kind and description, with ponderous beetles, moths, and flying ants, while the inside roofing of the sun-deck above you will be alive with billions of mosquitoes. You share your victuals with these nocturnal visitants, and while some of them are varying their diet by sucking as much nice fresh European blood as they can manage, you are retaliating by absorbing quantities of them in your soup. But one soon gets accustomed to these commonplaces of African travel, and when you turn in, inside your mosquito curtains rigged over your camp-bed on deck, and listen to the vague murmurs from the mysterious world of night all round you and breathe in the aromatic scents from the forest hard by, you would not, on the whole, change your quarters for a king's ransom.

And you learn so much—amongst other things, initiation into pidgin English in converse, or attempted converse, with your "boys" whom you have picked up down south. They may be full-grown men, but custom requires that they should be called "boys." A very short and obese railway surveyor I met in the wilds of the north possessed as a "boy" a stalwart Hausa of splendid proportions and fully six feet high, who could have tucked my little friend under his arm and walked off with him with ease. What particular idea has guided the construction of the barbarous lingo known as pidgin English is beyond me. But the result is something of this kind. Does your boy wait upon you with some particular request you feel too lazy to attend to at the moment, in lieu of saying "presently," you tell him to "wait small." Are you disturbed in your day dreams by a loud-voiced squabble, and wish to threaten the offenders with dire consequences, instead of saying something mild such as, "Stop that infernal row or I'll break your neck," you are supposed, in order to make yourself vocally comprehensible, to go into a rigmarole of this kind: "Stop dem palaver one time or big palaver go lib." Personally, I always found the modest "Shut-up" quite sufficient, which increases my scepticism as to the value of pidgin English. Do you wish the lamp lowered, you gravely tell your boy to "Kill dem lamp small." "Chop him," sounds blood-thirsty, but it only means "Eat it." Gripping his body firmly with his two hands, your cook volunteers the statement, "Sick catch me, massa," meaning that he has developed a pain—in his head. In such cases I recommend Epsom salts as an infallible cure.

And so we proceed up past Onitsha, a busy trading station, and famous for a native market whence the representatives of divers and erstwhile hostile tribes congregate together at stated intervals. And here it is that for the first time one sees in appreciable numbers, alongside the semi-naked Pagan, the Mohammedan in his flowing robes and turban. Most interesting is it to watch on market day the dug-outs owned by wealthy native merchants coming across the river in the early morning, most of them flying banners with some strange device, with drums beating, and the rowers putting up their monotonous chants, full of people, of sheep and goats, and piled up high with merchandise of all kinds. From Idah onwards the scenery undergoes a complete transformation. The land rises into high valleys and slopes. Mountains detach themselves from the horizon. The vegetation becomes scarcer, and massive boulders of grey granite make their appearance. In the vicinity of the banks a superior form of cultivation is now to be detected—yams and guinea-corn in parallel lines and raised ridges. Cattle can be observed. It is a new world we are entering. We stand at the threshold of the Mohammedan North. We cross that threshold at Lokoja, where the Benue, the Niger's great eastern tributary, falls into the parent stem. A magnificent view can be obtained of the confluence from the summit of Mount Patte behind Lokoja.

Here at this active centre of trade, the commercial halfway house between north and south, we plunge into the picturesque civilisation of Islamic Nigeria. We shall not here see, indeed, that civilisation at its best—its ceremonial, its courts, its political and social machinery. For that we must go further north still. But Lokoja, as the southernmost Mohammedan trading *emporium*, is replete with interest and humming with native life. Here it was that on January 1st, 1900, Sir Frederick Lugard hoisted the Union Jack as first High Commissioner for Northern Nigeria.

It has been said—I think Sir Percy Girouard was the author of the phrase—that Northern Nigeria has suffered through having been too easily acquired. By this, I take it, he meant that if its acquisition had cost the British taxpayer more, and had been attended by considerable fighting in which many of our officers had

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lost their lives, public interest in the country would have been keener. There is unhappily a good deal of truth in that remark. The achievement has been carried through so expeditiously, and with such absence of fuss and advertisement, that the public simply does not realise what a big thing it is. In a few years—from 1900 to 1906—at a minimum of expense and loss of life, a country 250,000 square miles in extent, containing some ten million inhabitants, was brought under control, under circumstances—mere physical circumstances, alone—of the utmost difficulty. And this result was achieved by a handful of white officers and officials, and a handful of black soldiers, with, at their head, a man of untiring energy and administrative capacity, in a land almost virgin of adequate routes of communication, unmapped, largely *terra incognita*, inhabited not by a few Pagan tribes lacking all cohesion, but in great measure ruled by able and astute Mohammedan Emirs, who for a century had held a sway, nowhere seriously disputed, over the mass of the population; rulers who could put many thousand cavalry into the field besides a great mob of foot-men. I do not think the annals of the Empire record a more brilliant feat. It was much more than a mere success in arms, for although at one moment the military danger was pressing, it never matured, and the actual resistance, though not on one or two occasions to be despised, was strictly localised and relatively insignificant. No, it was above all a feat, not of military prowess, although I do not under-rate that, but of statesmanship which, having for its goal the essential and necessary establishment of supreme British control, yet determined that once that control was accepted, the government of the country should be left, under Residential advice and supervision, in the hands of the country's natural rulers; that the existing social structure should not be shattered and, of course, that the religious beliefs of the people should be respected. From the outset Sir Frederick Lugard made it clear that our military action, forced upon us by circumstances which at this distance of time we can all unite in admitting to have been compelling, was directed not against the people of the country or their institutions, but against certain individual rulers from whose excesses—for which those rulers were but partly responsible—the people themselves suffered in their persons and property. This was the mainspring of Sir Frederick Lugard's success. But even so his work would have lacked permanence save for two factors: the character of the men whom he selected as Residents, and without whose sagacity, tact and firmness the position won would have been gravely compromised, and the circumstance that when he left the helm in 1906 he was followed in supreme authority by a man who not only continued the policy Lugard had so well begun, but who brought to the problems awaiting solution—and most vital of all the problem of land tenure, the basis of the entire social fabric of the country—a penetrating and sympathetic insight, a power of imagination, and a grasp alike of fundamentals and of opportunity, which crowned the edifice. That man is our Chairman to-night, and I beg him to believe that I venture upon this modest tribute in no spirit of flattery induced by his presence. I should have said as much and probably a good deal more if he had not been with us. Between them these two men, and the small band of experienced Residents assisting them, have laid the foundations of the only effective and just system under which the African tropics can be administered—governing on native lines. It is no disparagement to Sir Henry Hesketh Bell, the retiring Governor of Northern Nigeria, who has been in charge of the Protectorate for the past two years, to say that he found the edifice in being, and has loyally contributed to its maintenance. Of the land policy inaugurated by Sir Percy Girouard—the substance of which is the legalisation of the native system of tenure, the elimination of the speculator in land, and the foundation of a future land revenue—it may be confidently asserted that it is a bold and magnificent piece of constructive statesmanship. The Colonial Office—Lord Crewe was then Colonial Secretary—is to be warmly congratulated upon having sanctioned it. It is a policy which must rejoice all those who have pleaded for a scientific treatment of these great tropical African problems, and who realise that lack of comprehension and bungling in regard to indigenous systems of tenure have been primarily responsible for many disastrous mistakes, not only in Africa, but elsewhere.

With your permission, we will now talk round the slides. Here is Baro, the starting point of the railway to Kano—now complete, save for one or two bridges—and the terminus of our up-river journey. To convert this spot into a suitable landing-place, it had to be literally turned inside out. The high hill which you see immediately facing the

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river had to have its flank cut open; a slipway, a jetty and workshops, had to be evolved out of nothing, and the erection of buildings undertaken on the hill-top, to place the European staff out of range of the mosquito-infested swamp which, at that time, was Baro's chief attraction. The tremendous energy of the Director, Mr. Eaglesome, was not satisfied with dwelling-houses. He must needs convey water to the hill-top too, to say nothing of a hospital, which combination doubtless was responsible for saving many a young fellow's life. It is characteristic of the man who built this railway and of the methods employed, that Mr. Eaglesome's office at Baro boasts of nothing more luxurious than a cement floor, bushpole rafters, and an iron roof covered with thatch. Eighteen months ago the railway had only reached a point known as the Kaduna crossing, and the rest of the journey to Kano had to be done on horseback, a matter of nine days' trekking. I say, had to be done, but I mean no disparagement to the railway. For personal enjoyment in travelling through a country of this kind, give me a horse between my knees and the freedom of roaming over the great open spaces, before any railway in the world.

So early one morning, as the stars are paling and the crisp air starts fresh and chill, we start off on a journey replete with the most vivid interest, difficulties not worthy of mention, and humorous incidents not a few to keep us cheery —a nine days' trek to Kano, followed by a thirteen days' trek into the Bauchi highlands, where the tin we hear so much about is to be found, and eleven days' back to the advancing railway by another route; some six weeks in the saddle, including stops, six weeks of elbow room, six weeks of days in the glorious sun, and of nights under the equally glorious stars, six weeks of life—and the God of the open air be thanked for it. Of good augury is the start, which begins with the amusing sight of watching the evolutions of the cook over the head and back of his horse, an animal which the cook—coming as that worthy did from the Bini country, where they don't grow horses—had perhaps never seen, had certainly never attempted to mount. Four times the unfortunate *chef*—who was the only fool I met in Nigeria except the Court fool of the Emir of Zaria, whose portrait you shall presently see—clambered upon the back of his *Rosinante*, and four times she deposited him with unnecessary emphasis upon various parts of his anatomy, amid peals of merriment from the rest of the crew. For his part, being of a grave and melancholy disposition—the gravity of complete mental vacuousness—and rejoicing in the name of *Minehoho*, he saw no joke in the matter at all. And here, together with my Mohammedan head-man Kolo, who does not appear in the picture, and whose virtues I should like to commemorate in verse had I the power, are my companions for many unforgettable days, the indispensable carriers, flotsam and jetsam of Africa, great wastrels and altogether delightful people. At least, I found them so, even when, on one occasion, they got drunk on palm wine, and got me into trouble with the fraternity of local butchers in a Hausa town, and although they sometimes lost their way, reducing me, for a time, to the tortures of thirst.

Now and again in our peregrinations, up hill and down dale, past flourishing native settlements and past the ruins of erstwhile prosperous communities, laid waste in the forays which preceded the advent of British rule, through lonely stretches virgin of human life, and through waving fields of guinea-corn, sugar-cane and cotton—we cut across the track of the future line.

Here is a busy scene of rail- and plate-laying. The handful of Royal Engineer officers on the Baro-Kano line have beaten all records in the matter of rail-laying in tropical Africa, which is not to be wondered at, for the vocabulary of the Northern Nigerian men does not contain the word "impossible," they can make bricks without straw, and the building of this line at a maximum of speed and a minimum of cost has been a veritable *tour de force*—being constructed, moreover, under a system of native labour which, I should imagine, will henceforth be the model to be followed in other parts of Africa: a system in which the Political Officers, the Native Administration and the labourer have been hearty co-operators in a common end.

On the fourth day out we reach Zaria, one of the great red-clay walled cities of Hausaland, boasting a long line of kings, and many wise and holy teachers, rising out of a vast cultivated plain dotted with fantastic piles of granite resembling—where all is mediæval, or perhaps biblical would be the best description—those mediæval castles which you can see scattered along the heights which border the Rhine.

This slide will give you some idea of the picturesque ceremonial surrounding the native rulers of Northern Nigeria. It represents the Emir of Zaria accompanied by his old-world

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cavalry, standing at the door of the tent lent him by the Administration on the occasion of last year's Durbar, which was held at Zaria with great pomp and circumstance, many Emirs congregating together for the occasion with their thousands of mounted followers. And this slide represents the same Emir—one of the most learned and astute of the Fulani Emirs—on trek, visiting some of his outlying districts. The curious headgear you observe on some of his attendants is a straw hat made in the Nupe country, and often worn on top of the turban. It looks rather top-heavy in the picture, but in real life does not appear in any way incongruous.

Five days beyond Zaria again—the last two covered on a fine native road, dotted with magnificent trees through as smiling and fertile a land as one might wish to see, where great herds of white hump-backed cattle graze contentedly, passing numerous native caravans of long-distance traders, men and women with their little children, clad in multi-coloured raiment, carrying all manner of articles on their heads, driving convoys of heavily laden pack donkeys and pack bullocks, and droves of oxen, sheep and goats before them, with an occasional camel or two—and we come within sight of the most remarkable native city in all Africa, the far-famed Kano, with its great enfolding walls, thirteen miles in circumference, from 20 to 50 feet high, and from 20 to 40 feet thick at the base, pierced by thirteen deep gateways. Here is one of them, with platform and guard-house, and massive doors heavily clamped with iron, with its written records dating back eight hundred years.

Kano, of which you see here a section, is worthy of a lecture in itself. First built in the reign of our King Henry VIII., and famed throughout Africa for the industry of its inhabitants and the fertility of the province of which it is the centre, it has excited the astonishment of every European who has visited it. When he first entered it, Lugard exclaimed that it exceeded anything he had ever seen "or even imagined" in Africa. Its market, perhaps the most celebrated in Africa, is a wonderful sight. Here you may see from 5,000 to 7,000 people daily buying and selling in the great open square lined with clay-built booths—a sight which, in its colouring, its setting, the brilliant sun above, the clamour of voices, the bustle and dust, is fairly bewildering. A tiny corner of it is here given. At no spot in Africa can you see such an astounding medley of different tribes—the keen-featured Hausa, the Fulani, the thick-lipped Kanuri from Bornu, the Nupe vendor of glass and brass ware, the tall, lithe, fierce Taureg from the far north, with the black veil half drawn across his face, the supercilious white-skinned Arab from Tripoli, who occupies a special quarter in the town. The merchandise on sale is even more varied. Every kind of native cloth produced from native looms, and noted for some special peculiarity or excellence from all over Nigeria, is here to be met with, together with Manchester cottons; every kind of locally manufactured agricultural and vocal instrument; all sorts of meats, vegetables and fruit, and plants for medicinal and dyeing purposes; local silver ware and cheap trinkets from Europe; leather work—such as saddles, bridles, despatch bags, leather cases for Korans, both locally manufactured and imported from North Africa; swords and daggers, some of beautiful workmanship; rough pottery; raw silk, indigo, potash, and heaven knows what besides. In one corner a cattle sale is going on; in another a bargain is being struck over some donkeys; in another horses are being led out for inspection—and fine beasts some of them are; in yet another, local dancers are performing to the sound of the inevitable drum furiously beaten. It is at once a market, a fair, and a gossiping centre which, for hundreds of years, has been renowned throughout fully one half of the African continent.

To my regret, I take leave of Kano, *en route* for the Bauchi highlands—a long trek through gradually ascending country, often wild and beautiful, very sparsely populated, bearing much evidence of desolating years of inter-tribal warfare and raiding. This slide will give you some idea of the country. It was never completely conquered by Mohammedan Fulani, Hausas, and Kanuri, and contains an agglomeration of pagan tribes, speaking many languages.

They go about almost naked. Some of them are daring barebacked horsemen, shooting with great accuracy with the bow. They weave beautiful grass mats, grow tobacco and cotton, and are learning to tap, without destroying, the numerous rubber trees which are found in many parts of the country. Tin occurs in patches all over this region, in almost every case alluvial, deposited in the beds of the rivers. The industry would appear to have a solid future before it, and the Bauchi country is less unhealthy than are the low-lying regions. But I am inclined to think that its healthiness, together with other features concerning it, has been somewhat exaggerated. Certainly, in my opinion, which

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is worth very little if anything—for I am no expert on the subject—the premiums at which some of the shares in the tin companies which have been floated are standing, are not justified. It would be a pity if the undoubted mineral future of the Protectorate were jeopardised through its getting a bad name with the investing public by premature Stock Exchange booms. The Gold Coast offers a recent and flagrant example of the inconvenience of these manœuvres. The railway which will in part tap the field is making good progress, and there are plenty of opportunities for capable young fellows of the right stamp with a moderate capital who are prepared to go out and really work and mine.

The predominant, though not the ruling, race throughout Northern Nigeria are the Hausas, and this slide is a typical specimen of a Hausa man. Their exact origin is wrapped in mystery, although it is generally thought that the original stock came from the valley of the Nile. They are a remarkable people; on the whole the most remarkable people probably in Africa. Their language is the commercial *lingua franca* of a considerable part of Western Africa, and they have many sterling qualities. Great agriculturists and traders, they have developed a form of indigenous civilisation under the influence of Islam and trade connections with Tripoli—and probably in remoter days with Egypt—which has no parallel in Africa. For centuries they have grown their own cotton, spun it into beautiful, enduring cloths, dyed it with dyes of their own manufacture, principally indigo, which is found in a wild state in the country, embroidered it with elaborate and tasteful designs, and sold the finished product over an enormous expanse of African territory. The Kano looms practically clothe the inhabitants of the desert regions which lie between Lake Chad and the southernmost oases of Fezzan. I venture to hope that that industry, that health-giving (under Nigerian conditions) and elevating industry, will not only not die out, but will be encouraged by Government to expand and develop. Sympathetic as I am towards the work which is being performed by the British Cotton Growing Association in its attempts to create a large export industry in raw cotton from Northern Nigeria, and sensible as I am of the just claims of commerce between Britain and Nigeria, I contend that it would be little short of a national disaster to the peoples of Northern Nigeria if the Administration interferes in any way to restrict or hamper the native weaving industry. I should much like to see an exhibition held in London of the products of the Nigerian looms. It would astonish a good many people, and a taste might grow up among the wealthier members of this wealthy community for these beautiful articles, for beautiful and artistic they are. Apart from the tens of thousands of Nigerian men and women to whom the industry gives direct employment, and the many more tens of thousands to whom it gives indirect employment, upon its maintenance are dependent several other handicrafts which, with its disappearance, would also die out. The same argument applies to the leather work, the tanning, the smelting and other crafts in which the Nigerian is proficient. The export of dyed goat-skins from Northern Nigeria has now attained a considerable figure.

The next slide is that of a pure-blooded member of the Fulani race, over whose origin scientists and writers on West Africa are continually wrangling. The type here shown is that of a young Fulani girl belonging to what are known as the bush or cow Fulani, the nomadic herdsmen and shepherds from whom have sprung the born leaders of men and spiritual reformers who, early in the nineteenth century, welded the Hausa States into a homogeneous entity, and who form to-day the ruling caste throughout Hausaland. In the pure type the complexion is an olive brown, the features refined and regular, the limbs delicate and graceful. It was my good fortune to meet with several encampments of these nomads off the beaten track—a wonderful people to come across in the heart of Africa. They are the owners of most, if not all, the vast herds which move over the face of Hausaland. I leave the Fulani more rapidly than I should like, but time is getting on.

Here is one of the Fulani Emirs on the march surrounded by his gaily dressed followers. The Emir of Kano is the veiled figure in the centre. You must in imagination clothe his retinue in reds and greens, and blues and whites, and yellows, paint under their horses' feet a red-brown soil, and above their heads a sky of blue to obtain any idea of the picture as it appears in real life. One of the predecessors of the present Emir astounded the bluff and simple sailor, Clapperton, the first white man to visit Kano, in 1824, by putting him through his paces as to the differences of opinion between the Christian sects, and winding up by asking him if he were a Socinian or a Nestorian. I am happy to say that I was spared this disconcerting experience in my conversation with his successor.

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The Jāfi, or mounted salute, is an exciting form of courteous salutation indulged in by the Nigerian Emirs and their followers, which it was my privilege to witness on several occasions. They charge down upon you at full speed, reining up their horses short and flinging up their right hands with a shout. On one occasion whilst breakfasting at the morning halt by the side of the great white road through the Kano province, I was the recipient of one such salute which, for the fraction of a second, appeared to me to be likely to end in my camp table, of somewhat flimsy construction, my breakfast and myself disappearing in the midst. However it only resulted in the deposit of a little extra dust in the porridge.

Here you see a somewhat similar charge by the quilted horsemen of Bornu, who resemble old crusaders; a Nigerian hunter who has attached to his forehead the head of the ground horn-bill, the *Burutu* bird as it is called, the more successfully to approach the game he is stalking; a Hausa trading woman, many thousands of whom you meet travelling up and down the roads, fine specimens of womanhood up to a certain age, with a free and graceful carriage, and the classical dress of antiquity; cooking meat—a Frenchman might call that picture *rognons brochette à l'Africaine.* Of Nigerian meat such as you see it in the markets, the less said the better.

I promised you a sight of the Emir of Zaria's Court fool. Here he is. Every inch a fool, the quaintest figure ever I saw as it sped along at a great rate in front of the Emir returning from a religious ceremonial. Judging from his countenance, the assistant seems to be qualifying for the office.

These two slides, which are my concluding ones, represent first a gathering of Nigerian Mohammedans clad in their best attire on their way to celebrate the festival of the Sallah, which marks the close of the fast of Ramadan. The second shows a section of a vast concourse of Mohammedans at prayer, bowing themselves before the supreme Creator of the Universe. At sunrise and at sunset, in every Hausa village, you will hear the cry to God Almighty pealing out, and an impressive sound it is, while men make their silent devotions, quietly, without ostentation—and then go their several ways.

I would like, with your permission, to say a few words about the subject of these pictures. They represent a great force in Nigeria which it is idle to attempt to ignore, still more futile to rail against; and which, in the administrative sphere, it would be positively wrong to try and undermine. I am speaking of this force in Nigeria, not elsewhere be it noted, and I assert, without fear of contradiction from any responsible person, that this social and religious force has, on the whole, raised, and immensely raised, the intelligence and the general standard of the races among whom it has become implanted. It has largely assisted in moulding in the heart of Negro Africa a civilisation, a system of civil government, of jurisprudence and of ethics, immeasurably superior to that which surrounds it in the non-Islamised pagan belts, and which it is in the essential interests of the people should be maintained by the British power, not weakened or invaded. It is founded upon the Koran, and whatever shortcomings the Koran may contain from our point of view as a moral guide, we must remember that administratively speaking we find ourselves, in Northern Nigeria, in the position of trustees for the people of the land. To those people, to these our Mohammedan subjects in Nigeria, the Koran is at once the constitution, the charter and the Bill of Rights. In the appeal to his faith many of us are prone to see in the Mohammedan mere fanaticism. It is a mistake. In that invocation the Mohammedan is appealing to his constitutional rights. It is, I think, often overlooked that Islam is not only a religion but a social system, and that in attacking the religion you attack the fabric upon which society reposes, and that in attacking that fabric you attack the religion. The two are one. An excellent point about that quality is the recognition by the rich of their responsibility towards the poor. With us our constitution is not connected with our religion, and in the result which ensues the Mohammedan could find perchance as much to criticise as we may find to criticise in Islam. Let us beware of doing anything to undermine the constitution of our Nigerian subjects, by introducing legislative and judicial machinery which does not, and cannot, prove a substitute for what they have. If the national scheme of education which has been set up in the Protectorate, upon admirable lines, is properly understood and supported from home that danger need not arise, at least through any initiative taken locally. But the danger cannot be said to be non-existent so long as there is any fear that the home public is improperly informed, and led to erroneous conclusions as to the character of the great religious and social force with

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which we are called upon to reckon in Northern Nigeria, and, in an increasing measure, in the south. A published study of what Islam in Northern Nigeria is, and what it is not, is much to be desired for public enlightenment at home.

I feel that my paper has been wretchedly inadequate to convey to you a tithe of what I should have wished to convey. I can conceive of nothing finer, nothing more calculated to stir the imagination, to bring out the uttermost in the moral fibres of a man, nothing more inspiring than the privilege of participating in this work of Empire-building as it is now being performed in Northern Nigeria. For here is the true article. None of your cheap and shoddy jingoism. None of your "damned-nigger" theories to corrode the work of Government. Building, not destroying; strengthening, not pulling down native institutions; preserving the natural heritage of the people—the land—for the people, not robbing them of it for the benefit of speculators; respecting those who in the Providence of God have come beneath the *ægis* of our protecting mantle; helping them along their own natural lines to expand to a fuller consciousness of civic responsibility; applying a policy which, while upholding the social fabric, the lofty courtesies and the national characteristics of an ancient race, will grant to its members opportunities and security which, without us, they could never have acquired. That is the real Imperialism. That is the task which is being carried out in your name in the vast spaces of Nigeria.

I am no blind worshipper at the Imperial shrine. I am acutely conscious that the word Imperialism has been too often prostituted to serve ends the reverse of noble. But in my opinion the constructive work for good which has been and is being performed in Nigeria cannot be over-estimated.

Of the men who are carrying it out amid enormous difficulties, one can say in Kipling's poem of "The Sea Wife":—

> "The good wife's sons come home again
>   With little into their hands,
> But the lore of men that ha' dealt with men
>   In the new and naked lands;
>
> "But the faith of men that ha' brothered men
>   By more than easy breath,
> And the eyes o' men that ha' read wi' men
>   In the open books of death."

These men are entitled to claim not our sympathy merely in their task, but our comprehending, our active and intelligent interest. Let us support them. Let us support with our sympathy and with our wealth their efforts to sustain a form of administrative policy through which alone the rule of the white race in the African tropics can be made a blessing and not a curse to their inhabitants, by which alone we, as a people, can justify our claim to the over-lordship of Nigeria. It is no less their due, than it is our manifest obligation.

DISCUSSION.

The Chairman, in inviting discussion, referred to the paper as a thoroughly instructive and accurate exposition of the present position of affairs in Northern Nigeria. After an absence of some years he could not, of course, associate himself with every sentiment which Mr. Morel expressed, but he could heartily endorse the broad and general views of native government to which Mr. Morel had given expression. When he (the author) had spoken of a certain duty which this country owed to Nigeria the speaker was again in sympathy with him. He would mention a matter to which Mr. Morel had not referred—namely, that while the speaker was in Nigeria, more than 10,000 northern Nigerians disappeared annually over their eastern boundary to proceed on the great journey from Lake Chad to the shores of the Red Sea, to do their duty towards the centre of their religion. Any foolish or intemperate interference with such a faith, which was both a faith and a rule, would prove disastrous. Only recently at Port Soudan, his aide-de-camp, who had been with him in West Africa, was greeted by two Hausa people, who, on his expressing surprise at recognition, explained that he had been seen by them two and a half or three years before in the native towns of Nigeria. That incident showed, the speaker thought, the character of their feeling, the faith which had come down through the centuries, and which should not be disturbed too rudely.

Dr. John Pollen, C.I.E., said that he spoke as one who knew nothing of Nigeria, beyond the fact that he had devoted his first-born to the service of the land, but he desired to express his appreciation of the admirable paper by Mr. Morel. He had heard many papers in that hall, but to none had he listened with so deep a sense of gratification as to the one delivered that evening. He admired particularly the great spirit of Imperialism displayed by the author, coupled, as it was, with that sympathy for others without which Imperialism was as nothing. He congratulated Mr. Morel upon having thrown so much light on the administration of a great dependency, which reminded him of his early experiences in India in a part of that country which greatly resembled Nigeria. The noble spirit of the lecture should certainly have an excellent influence upon the rising race of Englishmen.

The vote of thanks was carried unanimously and the meeting terminated.

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THE PHILIPPINE HAT INDUSTRY.

The native hat industry in the Philippines is developing as a result of increased demand for the articles in the United States and elsewhere, and the work done by the Philippine Bureau of Education in stimulating the people to increased production. The hats are commercially known as "bamboo," but most varieties are made from other materials. Hat exports in the fiscal year 1908 amounted in value to £34,000, and in 1911 to £61,600. The demand for these hats is said to be growing rapidly among American farmers, particularly in the Southern States. The selling price of the cheaper grades is about one shilling per hat, and the articles are serviceable, comfortable, cheap, and presentable. The Philippines also produce "Panamas" and hats of special weave. The "bamboo" hats include not only those made from bamboo fibres, but often from the buri palm. Bamboo hats proper are sometimes known as the "Baliwag" hat, as they are principally made in the town of Baliwag, Bulakan Province. This class also, however, includes the "Pulilan" hat, made in Pulilan, which is important in the export trade, and which, to jobbers, has come to mean a coarse bamboo hat. The American Consul-General at Hong-Kong states that the fibre for the bamboo hats generally is obtained from the Kawayan bamboo, the common bamboo of the Philippines, and generally consists of the layers of fibres in the middle sections of the plant torn apart, soaked, steamed or boiled, dried, bleached, and otherwise specially prepared. The varieties of hats produced from the buri palm are numerous. Four valuable hat fibres are produced from the palm—raffia, generally used for other purposes, buri straw, kalasiao straw, and buntal straw. Generally only one variety of these straws is developed in any one place, the rest being thrown away. Buri straw is produced from the unopened buri leaf, and the hats manufactured therefrom vary in price. Kalasiao hats, otherwise known as the Pototan hat, are produced from the midrib fibre of the unopened buri leaf. In general the hats are woven in imitation of the ordinary straw hat, and in general also they are rated as rivals of the bamboo hats, being somewhat more attractive and also more expensive. Buntal straw, which is extracted from the leaf-stem of the buri palm, is the material most popular certainly in the United States. These hats are of a beautiful texture, light straw in colour, durable and stylish. They are exported in five grades, according to the usual classification, extra, and 1 to 4. The bulk of the trade is in No. 3 grade. The straw also is taken into Baliwag and there worked up in the Baliwag weave, producing by far the finest hat in the Philippines. These are the hats generally sold in the United States. Before the new tariff Act these hats went mostly to France, where they were classified and labelled, and shipped to the United States as "Bangkok," "East Indian Panama," "Italian Straw," and other products. The trade in both the bamboo hats and the buntal, or other buri hats, is of growing importance in the Philippines, where both the Bureau of Education and the Bureau of Science are aiding in every way possible in spreading knowledge as to the industry and its possibilities. Apparently there is no limit to the hat trade of the Philippines, either in its volume, particularly as regards the cheaper grade hats, or in the quality of the output, which may be classed among the highest in the world.

CORRESPONDENCE.

A B C OF HYDRODYNAMICS.

Whilst thanking your critic for his review of my "A B C of Hydrodynamics," there is one point I should like to draw attention to, as it is liable to be misunderstood. The formation of a vortex is certainly referred to *in the chapter* on a viscous fluid flowing "by obligation"; but I have been careful to say that the flow is no longer an "obligation" flow when the vortex is being formed; if it were so a vortex *could not be formed.*

Whether I shall eventually be considered to have simplified the subject or not, remains to be seen. The whole study is, at present, so full of contradictions and complexities that the attempt at simplification was, at least, worth making. Professor Unwin, in his "Treatise on Hydraulics," says: "Pure theoretical hydrodynamics has proceeded but little beyond the consideration of the action of a perfect fluid without viscosity. The conclusions are *in no case correct for actual fluids*, and in some cases are in startling contradiction with the facts of experience." As I have attempted to show, the reason for this is that the *conditions are not the same* in the two cases; given the same conditions, the results are *very similar.*

What appears complicated in the book is only what may be called the "scaffolding"—which was chiefly inserted for the benefit of the critics. Remove this scaffolding, and the remainder appears to me to be quite within the grasp of any well-educated youth of eighteen.

My whole line of argument is based on the teaching of Lord Kelvin—whose contributions to the subject are, I think, shockingly neglected.

R. DE VILLAMIL.

OBITUARY.

HENRY OPPENHEIM.—Mr. Henry Oppenheim died on the 4th inst. at his residence in Bruton Street, Mayfair. He was the son of Simon Oppenheim, a banker of Frankfort-on-the-Main, where he was born in 1835. In 1850 his father settled in London and founded the firm of S. Oppenheim and Sons, bankers, Austinfriars. On the outbreak of the Crimean War, the firm assisted the Government by providing ships for the conveyance of food for the troops, a service for

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which they received the thanks of the authorities. Mr. Henry Oppenheim spent a winter in the Crimea superintending this work. After this he joined the firm of Alberti, Pinto, Oppenheim & Co., bankers, of Paris, and went to live in Cairo as the firm's representative in Egypt. The knowledge of Egyptian affairs which he there acquired enabled him to take an important part in persuading the British Government to purchase the Suez Canal shares. Mr. Oppenheim retired from business some twenty years ago. He was well known as a collector of pictures and objects of art. He joined the Royal Society of Arts in 1875.

GENERAL NOTES.

Rescue Work in Collieries. — The Home Secretary has issued a Rescue and Aid Order dealing with the formation and training of rescue brigades, and the supply and maintenance of rescue-work appliances in coal mines. The Order, which comes into force at once, will apply to all mines in which coal is worked, except in the case of such mines employing less than 100 men as may be exempted. The rescue brigades will be maintained on the following scale:—Where the number of underground employees is 250 or less, one brigade; where the employees number between 250 and 700, two brigades; where the employees number between 700 and 1,000, three brigades; where the employees number over 1,000, four brigades. Each brigade is to contain five persons, the majority of whom must be trained in first aid and hold a certificate of the St. John Ambulance or the St. Andrew's Association, and must undergo an approved course of training. Among the rules as to appliances are regulations for the provision of two suits of portable breathing apparatus for each brigade, the keeping two or more small birds or mice for testing carbon mon-oxide, one oxygen reviving apparatus, and an ambulance box, together with antiseptic solution and fresh drinking water. Similar regulations apply to the central rescue stations established to serve several collieries.

Exhibition of Silk Industry at Athens.— The official inauguration of the international exhibition of sericulture and the silk industry at Athens, under the patronage of his Majesty the King of Greece, will take place on May 19th. The exhibition, which will be held at the Zappion Palace, will remain open for two months. It will include everything connected with sericulture, as well as all machinery and processes used in the manufacture of silk. Special facilities respecting customs duty will be granted to foreign exhibitors, who will be allowed three square metres of space free of charge.

Chinese Coal Production.—While it is probable that many of the reports of unusually fine coal deposits that have long been a common feature of discussion of China's natural resources were greatly exaggerated, enough is known of some of the deposits to warrant the statement that China is well provided with fuel. At present six notable domestic sources of coal are available: one in the mining country centring about Chinwangtao, above Tientsin, known as the Kaiping mines; another in the mines in Shantung Province known as the Hungshan and Fangtse mines; a third in Honan along the Hankow-Pekin Railway, and worked by the Pekin Syndicate; another in Kiangsi-Honan border country south of Changsha, and known as the Pinghsiang mines; a fifth in the Chingching mines in Chihli Province; and a sixth in the Japanese mine at Fushun in Manchuria, and various other small fields. The output of the mines named during 1910 was 3,604,525 tons. This coal has been used in numerous local enterprises, on various Chinese railways, by Chinese naval vessels, and in Chinese Government institutions—like the mints, naval depôts, arsenals, and other Government factories—and a considerable quantity of it was exported, some to the Pacific coast of the United States.

The Italian Macaroni Industry.—The manufacture of macaroni in and near Naples is a flourishing industry, and the output is being largely increased. Several new factories have lately been erected, and with the increased demand for the product the wages of the workpeople in the various factories advanced proportionally. With a view to offset this, the large manufacturers are studying a new method of artificial drying. Many boys and girls are employed on piecework in these factories, and although labour is comparatively cheap the wages have nearly doubled in Naples during the last two years. Russian and Australian wheat seem to be largely used in the manufacture of macaroni; large quantities are imported from Taganrog. Wheat from Minnesota has been used to some extent.

Royal Society of Antiquaries of Ireland.— A Charter of Incorporation has been granted, under the Great Seal of Ireland, to the Royal Society of Antiquaries of Ireland, of which Count Plunkett, F.S.A., is President. The Society has now over a thousand members, and during the last few years has published archæological surveys of several Irish counties.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock:—

May 15. — Ernest Kilburn Scott, Assoc. M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere." Sir William Ramsay, K.C.B., Nobel Laureate, F.R.S., will preside.

May 22. — Gordon Craig, "Art of the Theatre." Miss Ellen Terry will preside.

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Indian Section.

Thursday afternoon, at 4.30 o'clock :—

May 16.—Neville Priestley, Managing Director, South Indian Railway, "Indian Railways." The Right Hon. Sir Edgar Speyer, Bart., will preside.

Colonial Section.

Tuesday afternoon, at 4.30 o'clock :—

May 21.—The Hon. J. G. Jenkins, "Australian Railways."

Howard Lectures.

Monday evenings, at 8 o'clock :—

Captain H. Riall Sankey, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." Four Lectures.

Syllabus.

Lecture III.—May 13.—Description of Diesel engines manufactured by various makers—Sizes in current manufacture and future possibilities—Speeds and weight for land and marine engines—Various kinds of oil available for Diesel engines; their characteristics, calorific value, and sources of supply.

Lecture IV.—May 20.—Economical results in respect of fuel and of total annual cost—Comparison of Diesel, gas and steam engines, in respect of capital cost, fuel cost, and total annual cost—Various applications to land and marine purposes —Other heavy oil engines—Semi-Diesel engines.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 13...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Howard Lecture.) Captain H. Riall Sankey, "Heavy Oil Engines." (Lecture III.)

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. Hugh Abbot, "Some Points in the Design and Management of a Modern Bottling Store."

Meteorological Society, Science and Art School, Southport, 5 p.m. 1. Mr. J. Baxendell, "Results of Hourly Wind and Rainfall Records at Southport, 1902–11." 2. Mr. J. S. Dines, "The South-East Trade Wind at St. Helena."

Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. G. Taylor Loban's paper, "Some Principles in the Valuation of Land and Buildings."

Tuesday, May 14...Roman Studies, Society for the Promotion of, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. 1. Annual General Meeting. 2. Miss Gertrude Bell, "The Parthian Palace of Hatra."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture I.)

Illuminating Engineers, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Annual General Meeting.

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. R. Renwick, "The Measurement of Densities by a Photographic Method."

Colonial Institute, Whitehall Rooms, Whitehall place, S.W., 8.30 p.m. Hon. J. M. Creed, "Settlement by 'Whites' of Tropical Australia."

Wednesday, May 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. E. K. Scott, "The Manufacture of Nitrates from the Atmosphere."

Geological, Burlington House, W., 8 p.m.

Imperial Institute, South Kensington, S.W., 4 p.m. Captain E. Nash, "The Pacific Coast Fisheries and their Relation to Emigration and Imperial Naval Policy."

Microscopical, 20, Hanover-square, W., 8 p.m. 1. Rev. Hilderic Friend, "British Enchytracids. IV.—The Genus Henlia." 2. Exhibition of Pond Life.

Thursday, May 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. Neville Priestley, "Indian Railways."

Royal, Burlington House, W., 4.30 p.m.

Linnean, Burlington House, W., 8 p.m.

Chemical, Burlington House, W., 8.30 p.m 1. Messrs. A. G. Green and R. N. Sen, "On Azo Dyestuffs of the Triphenylmethane Group." 2. Messrs. A. G. Green and A. E. Woodhead, "Aniline Black and Allied Compounds." (Part II.) 3. Messrs. J. T. Hewitt and D. B. Steinberg, "Action of Grignard Reagents on Esters of Dibasic Acids." Preliminary Note. 4. Mr. H Rogerson, "Chemical Examination of the Bark of Euonymus Atropurpureus." 5. Mr. C. Funk, "The Constitution of Aminotyrosine and the Action of Oxidases on some Tyrosine Derivatives.' 6. Messrs. W. F. Cooper and W. H. Nuttall, "Furane 2:5 Di-aldehyde." 7. Messrs. W. R. G Atkins and E. A. Werner, "The Dynamic Isomerism of Ammonium Thiocyanate and Thiocarbamide." 8. Messrs. T. A. Wallace and W. R. G. Atkins, "The Distillation and Densities of Mixtures of Allyl Alcohol and Water." (Part I.) 9. Messrs. E. Knecht and J. P. Batey, "A Modification of the Beckmann Apparatus by which Constant Readings are obtained in Determining the Boiling Points of Aqueous Solutions."

Royal Institution, Albemarle-street, W., 3 p.m. Professor H. T. Barnes, "Ice Formation in Canada. I.—The Physical Aspect." (Lecture I.)

African Society, Trocadero Restaurant, Piccadilly-circus, W., 8 p.m. Discussion on "Nigeria" by Sir Frederick Lugard, Sir Hesketh Bell, Sir Walter Egerton, Sir Percy Girouard, and the Right Hon. John Burns.

Electrical Engineers, Victoria-embankment, W.C., 7.45 p.m. Annual General Meeting.
8.30 p.m. Mr. A. W. Ashton, "Condensers in Series with Metal Filament Lamps."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Professor C. H. Firth, "The Ballad History of Charles I."

Aeronautical, at the Royal United Service Institution, Whitehall, S.W., 8 p.m. Mr. F. H. Bramwell, "Aeronautical Researches at the National Physical Laboratory."

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 8 p.m.

Sociological, at the Royal Society of Arts, John street, Adelphi, W.C., 8 p.m. Professor Westermarck, "Marriage Customs in Morocco."

Friday, May 17...Royal Institution, Albemarle-street, W., 9 p.m. Mr. W. Duddell, "High Frequency Currents."

Junior Institution of Engineers, at 39, Victoria-street, Westminster. Mr. G. C. Allingham, "Storage Battery Engineering."

Saturday, May 18...Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Plunkett Greene, "Interpretation in Song. Lecture II.—Rules."

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Journal of the Royal Society of Arts.

No. 3,104. VOL. LX.

FRIDAY, MAY 17, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

DEATH OF THE KING OF DENMARK.

H.M. King Frederick of Denmark, whose lamentable death has just been announced, was an Honorary Royal Member of the Royal Society of Arts, having accepted membership on the occasion of his visit to London in 1907.

POSTPONEMENT OF MEETING.

MR. GORDON CRAIG's absence from England will prevent his reading the paper on "The Art of the Theatre," which was announced for the 22nd inst.

NEXT WEEK.

MONDAY, MAY 20th, 8 p.m. (Howard Lecture.) CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., "Heavy Oil Engines." (Lecture IV.)

TUESDAY, MAY 21st, 4.30 p.m. (Colonial Section.) THE HON. J. G. JENKINS, "Australian Railways." THE RIGHT HON. LORD EMMOTT, Under-Secretary of State for the Colonies, will preside.

HOWARD LECTURE.

On Monday evening, May 13th, CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., delivered the third lecture of his course on "Heavy Oil Engines."

INDIAN SECTION.

Thursday afternoon, May 16th; THE RIGHT HON. SIR EDGAR SPEYER, Bart., in the chair. A paper on "Indian Railways" was read by MR. NEVILLE PRIESTLEY, Managing Director, South Indian Railway.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 15th, 1912; SIR WILLIAM RAMSAY, K.C.B., Nobel Laureate, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Abraham, Edward A. V., America-street, Georgetown, Demerara, British Guiana.

Smallbones, Robert Townsend, Loanda, Portuguese West Africa.

The following candidates were balloted for and duly elected members of the Society:—

Dubash Kader Sahib, Khan Bahadur D.K., Abiraman-Natham, Ramnad District, Madras, South India.

Gordon, Duncan Macdonald, Keng Tung, Southern Shan States, Burma.

Harris, Thomas J., Botanic Station, Bermuda.

Morris, James, jun., Westdene, Ashburton-road, Birkenhead.

Neely, David Bradley, M.D., M.P., Humboldt, Saskatchewan, Canada.

Rutton, B. N., B.A., The Mall, Lahore, India.

Seabrook, Bagster Roads, P.O. Box 96, Toronto, Canada.

Seabrook, Norman Bagster, P.O. Box 96, Toronto, Canada.

Wakefield, William Birkbeck, Wilcot, Bisley, Surrey.

The paper read was—

THE MANUFACTURE OF NITRATES FROM THE ATMOSPHERE.

By ERNEST KILBURN SCOTT, A.M.Inst.C.E., M.I.E.E.

Considering that it is only about ten years ago that the manufacture of nitrogenous products by electric power was proved to be commercially possible, the progress has been remarkable; indeed, this metallurgical development of electric power promises to be even more important than electric traction.

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The two main sources of fixed nitrogen are sulphate of ammonia from gasworks, etc., and sodium nitrate from the country of Chili. Table I. gives the sulphate of ammonia produced in this country in the years 1906, 1909, and 1910. It will be noticed that the principal increases between 1906 and 1910 are—from coke ovens, 115 per cent., and from producer-gas plants, 50 per cent.; the total increase being at the rate of about 26 per cent.

TABLE I.

SULPHATE OF AMMONIA.

	1906. Tons.	1909. Tons.	1910. Tons.
Gasworks . . .	157,160	164,276	167,820
Ironworks . . .	21,284	20,228	20,139
Shaleworks . . .	48,534	57,048	59,113
Coke-ovens . . .	43,677	82,886	92,665
Producer-gas plants	18,736	24,705	27,850
Total . .	289,391	349,143	367,587

The regular exportation of nitrate of soda from Chili began in 1830, and, as will be seen from Table II., it has increased at an extremely rapid rate, and is now about two and a half million tons per annum.

TABLE II.

EXPORTS OF SODIUM NITRATE FROM CHILI.

Year.	Tons per annum.
1830	935
1850	50,000
1870	222,000
1890	1,050,000
1907	1,600,000
1908	1,970,000
1909	2,108,600
1910	2,308,200
1911	2,420,400

Against these figures the output of calcium nitrate and calcium cyanamide, which are two of the main products of the electric fixation of nitrogen processes, seem small. The important thing to notice, however, is that electrical processes are now on a sound commercial footing, and very large extensions of plant have been recently made, and are in hand.

Table III. gives particulars of the installations for the manufacture of calcium nitrate by the *direct* process of Professor Birkeland and Mr. Sam Eyde. It will be noticed that, although the first experimental plant was started only nine years ago, already the company controlling the Birkeland-Eyde patents have installations aggregating 200,000 horse-power at work, and probably by 1916 another 300,000 horse-power will be at work. All the installations mentioned in Table III. are in Norway, but installations will no doubt be erected in other countries.

TABLE III.

INSTALLATIONS OF THE NORWEGIAN HYDRO-ELECTRIC NITROGEN CO.

Year.	Horse-power.	Name of Installation.
1903	25	Experimental plant at Frognerkilens.
1903	160	Experimental plant at Ankerlökken.
1904	660	Arendal.
1905	45,000	First Notodden (Svaelgfos).
1910	15,000	Second Notodden (Lienfos).
1912	140,000	First Rjukan Installation.
1913	120,000	Second Rjukan Installation.
1914	70,000	Vamma.
1915	80,000	Matre.
1916	70,000	Tyin.

The other electrically-produced nitrogenous manure, calcium cyanamide, is made by a more *indirect* method invented by Dr. Franck and Dr. Caro, and its manufacture is not confined to Norway.

Table IV. gives the principal installations, and it is of interest to note that, although the first one on a commercial scale was erected at Piano d' Orto in Italy only eight years ago, there are works in operation, and being built, which by the end of next year will be making calcium cyanamide at the rate of over a quarter of a million tons per annum.

The Nitrogen Fertilisers Co., which owns the Odda and Alby Works, works under licence from the North-Western Cyanamide Co., which company controls this country, Norway and Sweden,

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TABLE IV.

INSTALLATIONS FOR MANUFACTURE OF CALCIUM CYANAMIDE BY THE FRANCK AND CARO PROCESS.

Name of Company.	Place of Installation.	Output per annum in tons.
Nitrogen Fertilisers Co. (North-Western Cyanamide Co.) .	Odda, Norway	15,000
” ” ” ” ” . . .	Alby, Sweden	15,000
Società Italiana de Prodotti Azotate	Piano d' Orto, Italy	4,000
Società Italiana per il Carburo de Calcio	Terni, Italy	15,000
Società Piemontese per il Carburo de Calcio	San Marcel, Italy	3,000
Société Française pour les Produits Azotes	Martigny, Switzerland . . .	7,500
” ” ” ”	Notre Dame de Briancon . .	7,500
Bayerische Stickstoff Werke	Trostberg, Bavaria	15,000
Ost-Deutscher Stickstoffcalf und Chemische Werke . . .	Bromberg, Prussia	2,500
A. G. Stickstoffdunger	Knapsack, Germany	18,000
Società per l' Utilizzazione della Forze Idrauliche della Dalmazia	Selenico, Dalmatia	4,000
” ” ” ” ”	Dugirat, near Almissa . . .	80,000
Japanese Nitrogen Products Co.	Kinzei, near Osaka	4,000
American Cyanamide Co.	Nashville, Tennessee . . .	4,000
” ”	Niagara	12,000

Belgium, and all the British Colonies, Protectorates and Dependencies, except Egypt and Canada. The Odda factory is now being enlarged, and at the beginning of next year will be producing 73,000 tons per annum.

In the United States the American Cyanamide Co. is about to erect a works in Alabama to manufacture 24,000 tons per annum.

BIRKELAND-EYDE FURNACE.

This furnace, invented by Professor Birkeland and Mr. Sam Eyde, of Norway, depends on the inter-action of an alternating-current arc in a constant magnetic field. The furnace, as installed at Notodden, consists of a circular sheet-steel drum about 8 ft. in diameter and 2 ft. wide, lined with refractory firebrick, and having a disc-like space in the centre, $6\frac{1}{2}$ ft. diameter and $1\frac{1}{4}$ in. wide. Air is supplied at the centre of the furnace by a Root's blower, whilst a channel round the periphery of the disc space carries off the gases and unoxidised air, as shown in Fig. 1.

Two electrodes, one of which is shown in Fig. 2, project into the centre of the furnace, and are approached to within about $\frac{1}{8}$ in. They are copper tubes, $1\frac{1}{2}$ in. diameter and $\frac{5}{8}$ in. thick, and have water circulation to keep them cool.

Surrounding the points of the electrodes there is a magnetic field of about 4,500 lines of force per square centimetre. Alternating current at 5,000 volts and fifty periods per second is sup-

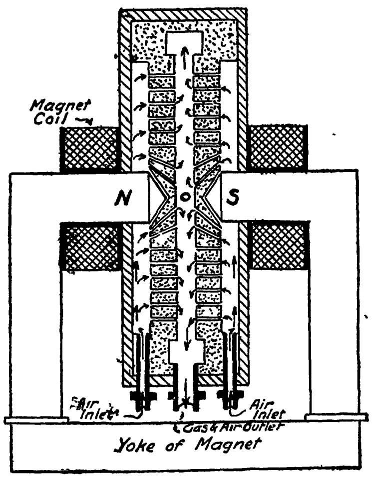

FIG. 1.

plied to the electrodes, and direct current flows round the coils to produce the magnetic field.

When an arc is struck between the electrodes, it is at once deflected in a direction perpendicular

to the lines of force, and the necessity of having alternating current applied to the electrodes will be appreciated from the fact that with direct current the arc would be deflected to one side only. As each electrode is alternatively positive and negative, the arc is projected outwards first to one side and then to the other, thus giving a disc of flame about 6 ft. in diameter. The speed at which the arc moves outward is extremely rapid, and as the formation of a new arc is practically instantaneous, it appears to the eye as a sheet of flame.

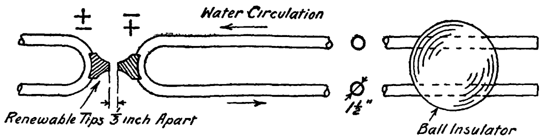

FIG. 2.

When the extremities of the arc retire along the electrodes, the arc increases in length, its resistance also increasing, until the tension is such that a new arc strikes between the points of the electrodes. The resistance of this short arc being smaller, the tension of the electrodes suddenly sinks to a point that will not sustain the long arc, which is thus extinguished. Another arc starts, and so the process goes on.

An inductive resistance is a very necessary piece of apparatus to have in series with the arc, because its self-induction automatically effects a displacement of phase according to the currents flowing, thus enabling the arc to burn steadily.

The writer assisted Mr. Howles with some experiments in fixation by nitrogen about thirteen years ago, and it was then that the necessity of having an induction coil in circuit was noted. Without it the arc could not be maintained steady, but with it the arc was quite steady. The experiment was made at Messrs. Johnson and Phillips', Old Charlton, and a transformer that happened to be handy was used for the purpose.

It should be noted that any furnace working with alternating current has necessarily a considerable phase difference. In other words, the power factor is low, and therefore, in estimating the sizes of dynamos and cables, due allowance has to be made. This, of course, raises the cost of electric energy. For ordinary power supply, a power factor of ·85 is quite usual, but with fixation of nitrogen furnaces, the power factor is only about ·6.

A curious feature of the arc flame is that it is not quite concentric. When looked at through coloured glasses the extremities of the arc appear like glowing spots upon the sides of the electrodes; on the positive electrode they are small, and fairly close together, whilst on the negative electrode they are larger and further apart. The reason for these spots appears to be that the arcs solder themselves, so to speak, to the electrodes, and the magnetic lines of force make the extremities of the arcs move along in leaps. For some reason not yet explained, the extremities of the arc cling more closely to the negative than to the positive electrode, and, therefore, the flame extends farther along the positive electrode than along the negative, as shown in Fig. 3.

When the flame is burning it emits a loud noise, from which the furnace attendant can judge of

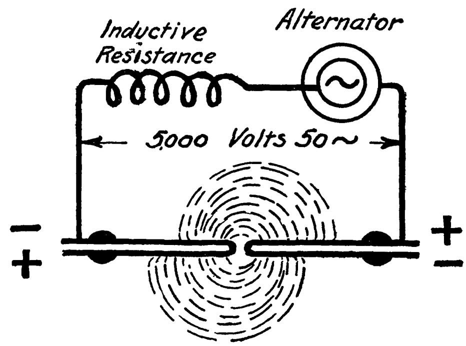

FIG. 3.

the number of arcs formed per second. The electrodes are changed and repaired every 300 hours, and the fireproof lining every fourth to sixth month. The temperature of the flame is about 3,500° C., and the temperature of the escaping gases is between 800° and 1000°.

Each of the furnaces at Notodden takes 600 kw., and the furnaces at the Rjukan works each take 3,000 kw.

SCHONHERR FURNACE.

This furnace was invented by Dr. Schonherr, of the Badische Anilin und Soda Fabrik of Germany. As installed at Christiansand, it consists of a long iron tube fixed vertically, through the centre of which an arc 16 ft. long is maintained. Alternating current at 4,200 volts, fifty periods, is used, and each furnace takes 600 horse-power. Air blown through this tube with a whirling motion

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keeps the arc in the centre. The electrode at the bottom consists of an iron rod which passes through a copper water-cooled tube. The iron rod is pushed upwards, as it burns away to ferric-oxide, and fresh rods are screwed on as required, so that the process does not stop. At the top of the tube there is the water-cooler, and it is inside here that the arc ends by striking across from the centre to the side of the tube.

As will be seen from the arrows in Fig. 4 the incoming air passes through annular tubes, on each side of which there are the hot gases from the furnace. The air is thus heated to about 500° C. before it reaches the arc. After passing through the arc, where some of it is heated to about 3000° C., it reaches the water-cooler, where its temperature is then suddenly reduced. At this point there is a rapid mixing of the highly heated nitric oxide next to the arc, with the cooler air that is whirling past, and the gas becomes permanently fixed. The nitric oxide and air leave the top of the cooler at about 1200° C., and pass away to a gas flue, common to all the furnaces, where the temperature is reduced to about 850° C.

The plant at Christiansand is entirely occupied in making sodium nitrite for the production of aniline dyes, etc. Previously sodium nitrite had been made by the reduction of Chili nitrate with lead, but this method of production has now practically ceased.

The nitrite made from the nitrogen of the air is so satisfactory and so cheap compared with the old methods, that now practically the whole supply of the world, valued at £160,000, is obtained by electricity.

In order to produce it the temperature of the gases is not allowed to fall below 300° C., and this keeps the nitric oxide about equal to the nitrogen peroxide. This mixture behaves as if it were nitrogen trioxide N_2O_3, and it is absorbed completely by being brought into contact with sodium hydroxide according to the following formula—

$$NO + NO_2 + 2NaOH = H_2O + \underset{\text{sodium nitrite.}}{2NaNO}$$

Calcium Nitrate.

As carried out at Notodden, the method of making calcium nitrate is as follows:—The nitric oxide gas and air pass from each furnace into two fireproof-lined gas-collecting pipes, about 6 ft. in diameter, lined with fire-brick. These pipes convey the gas to four steam boilers, the heat given off by the gases being used to raise steam for concentrating the products and for driving the air compressors for pumping acids, soda, etc. The gases then go through tubes in the evaporating tanks, after which the temperature is down to about 250° C. The temperature is lowered still further, to 50° C., by passing it through a number of aluminium tubes over which cold water is flowing. The gas then enters the oxidation tanks, which are large vertical iron cylinders, having acid-proof linings. Here it continues to take up oxygen to form nitrogen peroxide, the percentages being now about 98 per cent. air and 2 per cent. nitrogen peroxide.

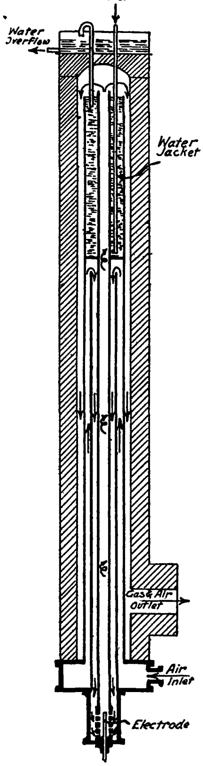

Fig. 4.

The nitrogen peroxide is brought into contact with water to form nitric acid, in two series of four towers. These towers are built of granite and are filled with broken quartz, this substance and the granite being chosen because they are not affected by acid. Each tower measures 2 metres square by 10 metres high, and it has been found that they will give an absorption of 3·3 kilograms of nitric acid per cubic metre of space per 24 hours.

The liquid trickles down through the quartz, and meeting the nitrogen peroxide gas, combines with it. The liquid moves from tower to tower in the opposite direction to the gas. Thus the fresh water enters at top of the fourth tower, it flows down through the interstices between the

pieces of quartz and falls into a granite tank. From there it is pumped by compressed air to the top of the third tower, down which it trickles into another tank, and from which it is pumped to the top of the second tower, and so on.

When the liquid reaches the bottom of the first tower it contains about 40 per cent. nitric acid.

Recently some very remarkable results have been obtained by improving the material with which these towers are filled. By using special forms of earthenware instead of quartz, the towers can be reduced in size considerably, and as the cost of the towers is usually about four times the cost of the filling material, this means much cheaper towers.

The chemical equations are as follows—

In the electric furnace from 3000° C. down to 1000° C., nitric oxide, a colourless gas, is formed—

$$N_2 + O_2 = 2NO \text{ (nitric oxide).}$$

In the oxidation chambers, etc., from 500° C. down to 50° C., the red-brown gas nitrogen peroxide is formed—

$$2NO + O_2 = 2NO_2 \text{ (nitrogen peroxide).}$$

In the four acid absorption towers the nitrogen peroxide combines with water to form nitric acid and nitrous acid—

$$2NO_2 + H_2O = HNO + HNO_2 \text{ (nitrous acid).}$$

As the nitrous acid is unstable in an aqueous solution it gives nitric acid and nitric oxide—

$$3HNO_2 + H_2O = HNO_3 + 2NO \text{ (nitric oxide).}$$

The nitric oxide then combines with more oxygen to form again nitrogen peroxide, and the above equations are repeated—

$$2NO + O_2 = 2NO_2 \text{ (nitrogen peroxide).}$$

What is left of the nitrogen peroxide and nitric oxide gases pass to the fifth tower, when they meet sodium hydroxide to form sodium nitrite—

$$NO_2 + NO + 2NaOH = H_2O + 2NaNO \text{ (sodium nitrite).}$$

The nitric acid of 40 per cent. solution is sprayed on to calcium carbonate, and the carbon dioxide gas is driven off, leaving calcium nitrate—

$$2HNO_3 + CaCO_3 = CO_2 + H_2O + Ca(NO_3)_2.$$

The solution is then pumped into solidification pans, under which cold air is circulated to accelerate cooling, and the nitrate of lime stiffens into a brittle, crystalline mass. This is broken up into lumps, which pass to ball crushing-mills, where it is reduced to a granular state. The coarse powder is then raised by an elevator into a hopper, from the bottom of which it falls into barrels which hold 2 cwt. These barrels are lined with paper to guard against damp.

The analysis of the commercial calcium nitrate, Norwegian saltpetre, or nitrate of lime as it is variously called, is given in Table V.

TABLE V.

		Per cent.
Calcium oxide	CaO	25·83
Nitrogen	N	12·47
Water	H_2O	23·83
Carbon dioxide	CO_2	0·52
Magnesium oxide	MgO	0·41
Aluminium trioxide	Al_2O_3	0·71
Residue insoluble in hydrochloric acid	—	0·51

With the Birkeland-Eyde process, one kw.-year gives 500 to 550 kilograms of nitric acid, or 853 to 938 kilograms of nitrate of lime. The latter usually contains 13 per cent. of nitrogen, which corresponds to 111 to 122 kilograms of combined nitrogen. It is *guaranteed* to contain 12¾ per cent. of nitrogen.

The best result at Notodden has been 900 kilograms of nitric acid per kw.-year measured at the arc terminals and allowing for 100 per cent. nitric acid.

The percentages of nitrogen and comparative prices of the various artificial manures are about as given in Table VI.

TABLE VI.

	Content of Nitrogen.	Price per ton.		
	Per cent.	£	s.	d.
Sulphate of Ammonia from gasworks	19·75	13	0	0
Nitrate of soda from Chili	15·50	9	15	0
Nitrate of lime made by electricity	12·75	8	10	0
Calcium cyanamide made by electricity	18·00	10	0	0

THEORY OF FIXATION.

The problem is to raise the temperature as quickly as possible to over the igniting point of nitrogen and oxygen, and then immediately to cool the fixed gas and draw it off. The temperature of the burning nitrogen and oxygen flame is lower than the igniting point by about 200° C. There must be a "hot cold zone," that is to say, a zone in which at one part the temperature is enormously high, and at another part the temperature is as low as possible.

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As the electric arc gives in an easy manner the temperatures above ignition-point it is principally used. Some experimenters contend, however, that if by using a flame of carbon monoxide or a sprayed oil flame of carbo-hydrates a temperature near that of the electric arc was reached, then the results would be equally satisfactory. They point out that the ignition of nitrogen and oxygen takes place at 1800° C., and as the temperature of the electric arc is well over 2000° C., it is really much higher than is necessary.

It is not at all certain, however, that the effect is merely due to temperature. A more probable theory is that some of the oxygen is first formed into ozone, and that further on in the arc the extra atom of oxygen splits off, and being in a nascent condition readily combines with the nitrogen. In this connection it is interesting to note that Sir J. J. Thompson has demonstrated that under certain conditions N_3 does exist. Is it possible that O_3 and N_3 are first formed, and then the nascent atoms combine?

It is known that nitric acid is formed on the windings of high-tension alternators, and this is apparently due to silent discharge at normal temperature and pressure.

Mr. Cramp, whose investigations into this subject deserve to be better known, says, in a communication to the writer, that he is quite certain that ozone does enter into the problem, and that if the air charged into the furnace had ozone mixed with it, there would be an increased yield of fixed gas. A very small amount of ozone is likely to have a considerable effect; fifteen parts in one million is a high percentage. In the Central London Railway tube the percentage is only one part in a million, and yet the ozone is so powerful that its characteristic odour is quite noticeable.

The photograph, Fig. 5, shows that with alternating current the arc concentrates on one side, and the fact that ozone is a conductor may be partly or wholly responsible for this.

On several occasions it has been suggested that the yield would be higher if nitrogen and oxygen were passed through the furnace in combining proportions instead of in proportions in which they exist in air. Muthman says, however, that the proper proportions are one of nitrogen to *two* of oxygen, and his explanation is that as NO_2 is easiest to form, it is, therefore, formed first.

Several methods of fixing nitrogen have been proposed which do not depend on electric power. The principal one is due to Professor Haber, and it is of special interest just now, because the powerful German company, the Badische Anilin und Soda Fabrik is experimenting with it.

The gases nitrogen and hydrogen, in the proportions for forming into ammonia, are brought together under a pressure of 175 atmos. and they are said to combine in the presence of a catalyser such as osmium or uranium.

The Rjukanfos Installation.

The Rjukan installation is situated in Vestfjorddalen, East Telemarken. The saltpetre factories are situated at Saaheim, and the hydro-electric power-plant on the Maane River, half a kilometre away. The power-installation utilises part of the well-known "Rjukanfos," and has a working head of some 274 metres and a discharge of water of 47 cubic metres per second. The total electrical energy in the power-station is about 140,000 horse-power, divided into ten units, each of 14,450 horse-power. Each unit is, however, capable of producing 16,500 horse-power, and they are thus the largest hydro-electric units which have yet been constructed. The generators give a pressure of 10,000 volts, and the total energy is transferred to the nitrate of lime factory through a transmission line, for the most part made of bare aluminium conductors.

In the factory, some of the furnaces are of the Schonherr construction (of the Badische Anilin und Soda Fabrik), each of 1,000 kw. They are 23 feet long and require 40,000 cubic feet of air per hour. The other furnaces are of Birkeland-Eyde's construction, each of 3,000 kw. (See Figs. 6 and 7.)

The gases from the various furnaces have a temperature of about 800° C. when leaving, and they are led through brick-lined iron pipes to the coolers, which are mounted in a separate house. From there the gas goes to the absorption towers. These towers are arranged on the same system as at Notodden, namely, acid absorption for the greater part of the gases, and alkali ones for the rest.

The annual production will amount to 70,000 tons of nitrate of lime and 8,000 tons of nitrite. It will be exported in wooden kegs, exactly as at Notodden.

Regarding the question of the type of furnace, Mr. Eyde wrote on February 10th last, saying—

"The results now at hand from the trial management are not sufficient to entitle us to judge which of the two systems—the Badische or the Birkeland-Eyde system—is the most profitable one. For the present it may be declared that the proceeds by both systems very likely will turn out

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to be approximately the same. As you will note, however, from the above-mentioned figures, the Birkeland-Eyde furnaces may be constructed for a considerably greater energy than the other type. by which will be produced 70,000 horse-power, of which 50,000 horse-power will be utilised for the manufacture of nitrate of lime. Including the factory at Notodden, we will thus in a short

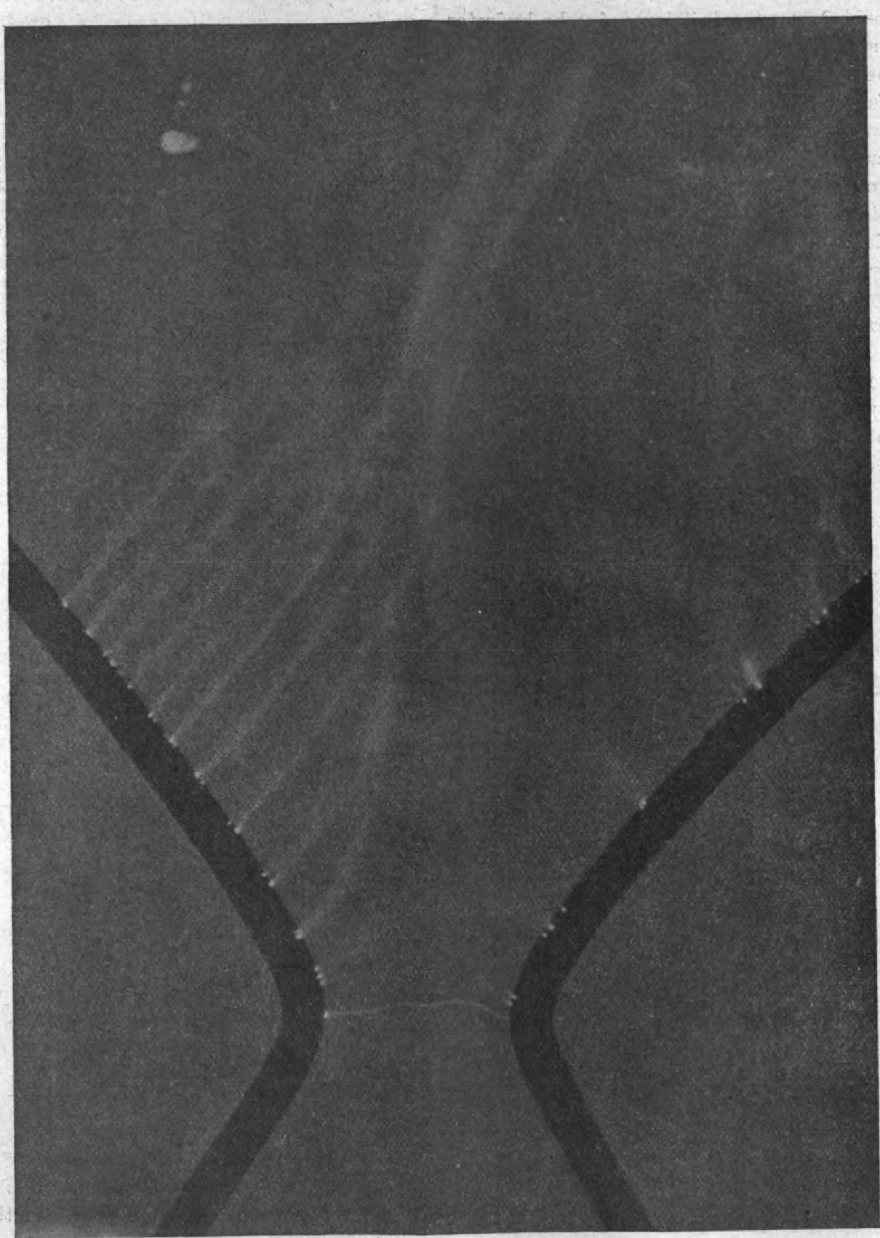

FIG. 5.—ARC FLAME, SHOWING CONCENTRATION ON ONE ELECTRODE WHEN WORKING WITH ALTERNATE CURRENT.

"A second power-plant is now under construction at Rjukan, intended for the installation of some 120,000 horse-power, which will likewise be used for the manufacture of nitrate of lime.

"Our company is further constructing a third power-installation, Vamma on the Glommen River, time utilise in all 370,000 horse-power for the manufacture of nitrate of lime."

It would appear that the Birkeland-Eyde furnace is preferred to the Schonherr because it is more compact and cheaper to build. The Schon-

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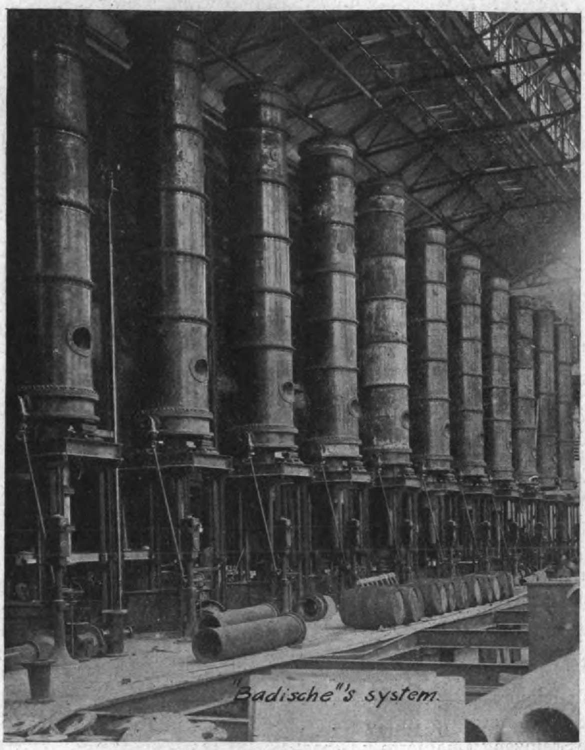

FIG. 6.—RJUKAN SALTPETRE FACTORY.
View of Furnace Room showing some of the Schonherr Furnaces.

herr furnace has to be built very high in order to increase its output, and this introduces constructional difficulties, also the difficulty of keeping the arc from striking into the side of the tube.

The present plant consists of ten generator turbines of 14,450 horse-power each, five of which were constructed by J. M. Voith, of Heidenheim, five by Escher Wyss & Co., of Zurich, and one exciter turbine of 1,000 horse-power by Kräerner Brug, of Christiania. The three-phase electrical generators coupled to the Voith turbines were made by the Allmänna Svenska, of Västeras, Sweden, and those driven by the Escher Wyss turbines were supplied by Brown, Boveri & Co., of Baden. The whole of the switchboard equipment was installed by the Westinghouse Co. Table VII. gives the names of the principal contractors.

The turbines are fed by individual pipe-lines of 1,250 mm. inside diameter at the top end, and 1,000 mm. inside diameter at the bottom end. The length of each pipe is 720 metres (2,360 ft.), the upper 300 metres consist of riveted pipes, and the longer lower part for higher pressure consists of welded pipes. The riveted pipes were supplied by Frederikstad's mek. Verksted, Frederikstad, Norway, and the welded pipes by Actiengesellschaft Ferrum, Zawodzie near Kattowitz, Germany. The supply and laying out of all of the pressure pipe-lines was done under the superin-

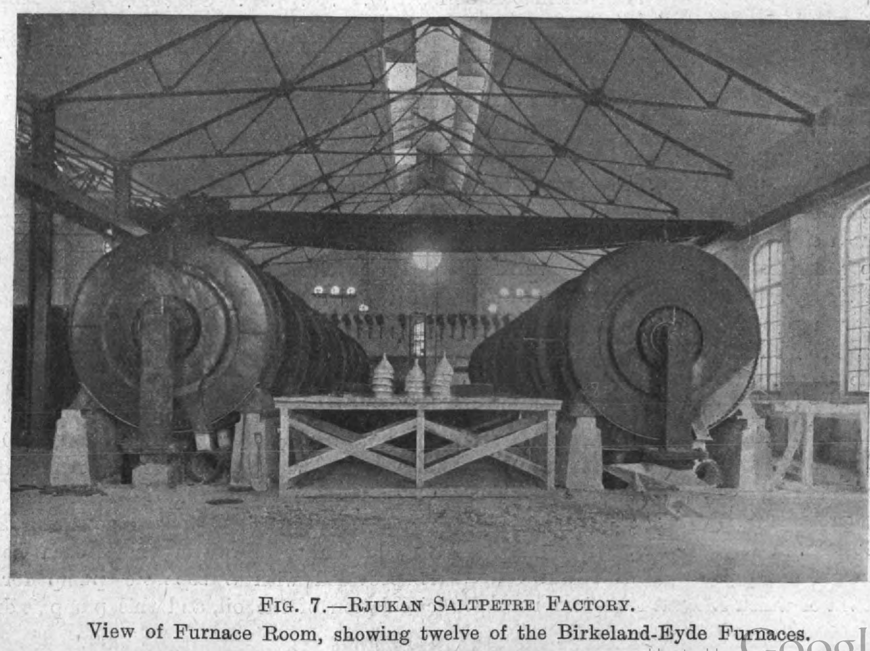

FIG. 7.—RJUKAN SALTPETRE FACTORY.
View of Furnace Room, showing twelve of the Birkeland-Eyde Furnaces.

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TABLE VII.

CONTRACTORS FOR THE MACHINERY, ETC., OF THE RJUKANFOS INSTALLATION.

THE POWER-HOUSE AND TRANSMISSION.

Turbine pipes	Ferrum, A. G.	Kattowitz.
	Frederikstad mek. Verksted	Frederikstad.
Turbines	Kværner Brug	Kristiania.
	Escher Wyss & Cie	Zürich, Switzerland.
	J. M. Voith	Heidenheim/Brenz.
Electric generators	Allmänna Svenska El.A/B.	Vesteraas.
	Brown Boveri & Co.	Baden, Switzerland.
Switchboard and instruments	Westinghouse Co.	Havre, France.
The Aluminium power lines	Heddernheimer Kupferwerk.	
Copper cables, etc.	Felten & Guilleaume Carswerk	Mülheim a/Rh.

THE SALTPETRE FACTORY.

Furnaces	Kristiania Staalverk	Kristiania.
	Kampens mek. Verksted	Kristiania.
Fire bricks and the masonry work for the pipe-lines	Gunnar Knudsen	Borgestad pr. Porsgrund.
Gas-piping	Kampens mek. Verksted	Kristiania.
	Drammens mek. Verksted	Drammen.
	Karlstad mek. Verksted	Karlstad (Sverige).
Fans	Kühnle, Kopp & Kausch	Frankenhal/Pfalz.
	Beck & Henkel	Cassel.
	Danneberg & Quandt	Berlin.
Coolers	Kampens mek. Verksted	Kristiania.
	Dingler'sche Maschinenfabrik	Zweibrücken.
Granite towers	Hyggen stenhuggeri	Hyggen pr. Drammen.
	Nedre Eker stenexport	Eker pr. Drammen.
Porcelain	Friedrichsfelder Steinzeugwarenfabrik	Friedrichsfeld.
	Westdeutsche Steinzeug, Chamotte & Dinas-Werke	Euskirchen.
	Franz Gerhardt	Schönebech a.d./Elbe.
Crushing mill	G. Polysius	Dessau.
Electrical machinery	Norsk A/S, Siemens-Schuckert	Kristiania.
	Elektricitats A/S A.E.G.	Kristiania.
	Norsk Elektrisk & Brown Boveri & Co.	Kristiania.
	Bergmanns Elektricitätswerke	Berlin.
	Maschinenfabrik Oerlikon	Oerlikon.

tendence and on the responsibility of J. M. Voith.

Each turbine is designed to work with a net head of 274 metres, and a normal output of 13,000 horse-power, when running at a speed of 250 revolutions per minute. The output may be increased to 14,450 horse-power.

The main sluice valve of 1,000 mm. is fitted on a taper connecting-pipe, and the valve is operated by hydraulic pressure by means of a cylinder with piston and a distributing valve. The piston-rod carries a relay which connects it to the valve, thus preventing the latter opening or closing too quickly and ensuring perfect safety. The distributing piston is designed and dimensioned to allow the valve being opened or closed under full pressure. This valve is provided, however, with a by-pass valve 150 mm. inside diameter.

The turbines are provided with twin Pelton wheels, each of which is driven by two nozzles. In the Escher Wyss turbine the lower jet does not strike the buckets until the latter have cleared the upper jet. Each of the runner wheels, which are mounted 1,800 mm. apart on a horizontal steel shaft, consists of a separate hub of cast steel, and on the circumference of each twenty-two cast-steel buckets are fastened. The buckets are held by means of two rings which provide that there shall not be any stress on the bolts, and yet prevent the buckets getting loose.

Bearings.—The turbine shaft, which is of Siemens Martin steel, is supported by two ring-lubricated bearings of 380 mm. diameter, and its diameter is increased to 470 and 480 mm. where the runner wheels are mounted. A forged-on flange coupling transmits the whole power of the turbine to the generator shaft. In addition to lubricating rings each bearing is provided with a separate pump for the circulation of the oil, and this pump is driven

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by the turbine shaft. It draws the warm oil from the bearings, passes it through a coil situated in the discharge pit of the turbine and then pumps the oil through a filter to the main shaft again. This device greatly increases the safe running. The bearings have to withstand the weight of the shaft and runners, and also the thrust due to the water jets. They are supported by a strong frame which is grouted into the foundations and held fast by anchor bolts.

Casing.—On the same side as the distributing pipe there is a strong frontal iron plate, to which the inlet bend and distributing piping are fastened. The upper half of the casing is made of wrought-iron 10 mm. thick, in two parts bolted to the foundation frame and to the frontal plate at the centre line. When the runner wheel has to be taken out for repairs, the upper part of the casing is lifted off. At the side of the casing where the shaft comes through it, deflector rings and water-splash guards prevent any water escaping from the casing. For the purpose of inspecting the buckets and nozzles a pit is provided in the foundations, by means of which it is possible to descend into the turbine chamber for that purpose.

The turbine-chamber walls are covered with iron plates from the foundation frame up to the ceiling of the tail-race, with a view to protect them from erosion as well as to prevent any leakages in the air-ducts between the turbines.

Nozzles.—The largest diameter of the water-jet when the nozzle is fully opened, is about 150 mm. In order to reduce the regulating power, the needle rod is provided with a balancing piston acting in opposite direction to two buffer springs. The latter have the tendency to close the needle. The power resulting from the closing energy of the needle and springs, and the opening energy of the piston, is so calculated that the needle is always balanced, no matter what the opening is. The turbine is regulated by simultaneously adjusting the four nozzles, which are connected to each other by means of rods and levers. A rod and lever connects the regulating shaft to the main shaft of the universal oil-pressure governor.

Guarantees.—For the speed governor and pressure regulator, as well as for the efficiency of the turbines, the following guarantees were given:—The turbines were designed to develop a maximum of 14,450 horse-power when working with a net head of 274 metres and running at 250 revolutions per minute. The efficiency was to be 76 per cent., when the quantity of water used was 5,200 litres per second. When running under the same conditions of speed and pressure, and developing normally 13,000 horse-power, the efficiency was to be 78 per cent. and the water used 4,650 litres per second. When load was suddenly thrown off to the extent of 25, 50, and 100 per cent. the variations of speed were to be limited to 3·5 per cent., 7 per cent., and 17 per cent. above normal, and the maximum increase of pressure in the pipe-line was not to exceed 15 per cent.

All these guarantees were easily maintained. In May, 1911, the pipe-lines were filled and the turbine started for the first time. A number of tests were then carried out, and about three months later the definite taking-over tests of all the turbines were made by Mr. Geheimrat Reichel, Professor of the Charlottenburg Technical School of Berlin. The output of the turbines was measured by electrical means, the quantity of water used was measured by the "Schirm Methode" in the tail-race. The highest efficiency that was attained was 82·6 per cent. with an effective turbine output of 11,000 horse-power. With nozzles fully opened the maximum effective horse-power of the turbines was about 16,000.

The maximum increase of speed was 15 per cent., whilst the increase of pressure above static head did not exceed 10 per cent.

The five Escher Wyss turbines are each coupled to three-phase generators made by Brown, Boveri & Co., of Baden.

At a power factor of ·6 each machine gives 17,000 Kva. at 11,000 volts, fifty periods per second. One of the machines gives the whole of the 17,000 Kva.

Four of the units are of the double-generator type, with a shaft common to the two. The two armatures are separated by a fireproof partition, so that if a coil of one should be burnt out the coils on the other machine are not affected.

Allowing for windage and friction, the guaranteed efficiency is 94·8 per cent. for the double generator, and 95·3 per cent. for the single generator. This is at full load, and with a power factor of ·6.

The voltage difference from full load to no load, and *vice versa*, is 1,400 volts. This may be necessary by the conditions of working the furnaces, as they are very subject to sudden changes.

The total weight of one generator is 205,000 kg. (200 tons). 92,000 kg. go to the rotating field and shaft. The armature weighs about 90,000 kg.

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The armature stampings are held in position in the cast-iron armature ring by vee grooves. Cast-iron rings clamp the stampings at the ends, and these rings extend to bottom of slots. The outside diameter of the armature is 6 metres, and the inside diameter is 4·4 metres. The radial depth of the laminated structure is 21·5 cm. To permit of overhaul and repair the armature is divided on its horizontal diameter.

The magnet wheel has a cast-steel hub and arms, and the periphery of the wheel is made up of solid forged steel rings. To these rings cast-steel poles are fixed, the ends of the poles being laminated. The poles are held by dovetails and cotters.

The field poles are wound with bare annealed copper on edge, and all the poles windings are in series.

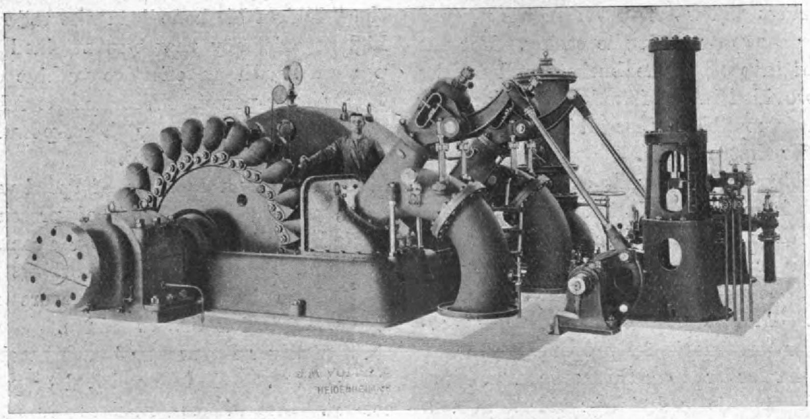

FIG. 8.—RJUKAN POWER-HOUSE.
15,000 horse-power Voith double turbine, running at 250 revolutions per minute.

The slip rings are of cast steel, and carbon brushes are used. The exciter is direct coupled and gives 130 kw. at 220 volts.

Every rotor was tested for mechanical strength by being rotated at 1·8 times the normal speed for half an hour, that is, at 450 revolutions per minute.

The bearings are supplied with oil under pressure, and the oil is cooled by water coils.

The other five turbines supplied by J. M. Voith are very similar to the above, with double-runner wheels and two nozzles to each runner. At the official tests all the guarantees were exceeded. Coupled to each of the Voith turbines is a double 8,400 Kva., 11,000 volts, 50 cycle three-phase generators made by the Allmänna Svenska Co. Each consists of two separate armatures and two revolving fields on a common shaft running on two bearings. By reason of the highly inductive load on the generators, the PF is only ·6, but with PF = unity, each machine would develop up to an individual capacity of 23,000 electrical horse-power. Each double generator weighs 250 tons.

Figs. 8 and 9 are from photographs of some of the plant used in the Rjukanfos power-house.

PAULING FURNACE.

This furnace was invented by Mr. H. Pauling, of Gelsenkirchen, Westphalia, and he took the idea from the well-known horn-break lightning arrester. As installed at Gelsenkirchen and Innsbruck it consists of two hollow iron electrodes, arranged to form a vee, which at the lowest point is about 4 cm. across, as shown in Fig.10. At this point there are two lighting knives, which can be approached to within a few millimetres, and are readily adjustable. The arc strikes across and runs up the diverging electrodes by reason of the natural convection currents, and the repelling action of its own magnetic field, but principally because of a blast of heated air from an air-duct immediately below. The arc diverges as it follows the shape of the electrodes, and it attains a length of about a yard. At each half-period of the alternating current a fresh arc forms, so that the result is the equivalent of a triangular sheet of flame.

An important feature is that the wall which divides the two parts of the furnace is hollow, and gas and air which has been through the furnace previously and been cooled, is blown through this central passage. As will be noticed from Fig. 10, this cool gas and air strikes into the top of the arc flame, and it serves to cool the gases which have just been formed. The two arcs are in series, and the furnaces

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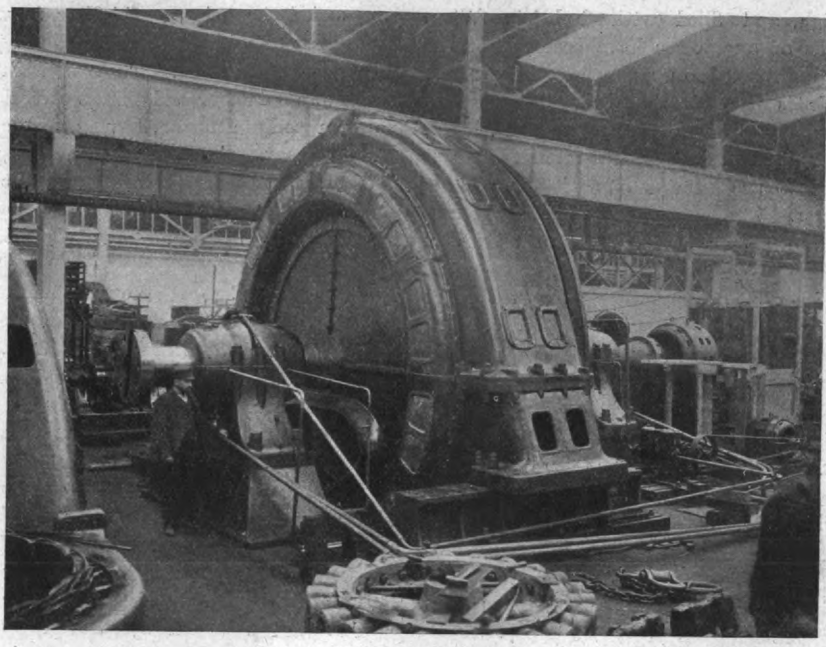

FIG. 9.—RJUKAN POWER-HOUSE.
One of the 8,400 Kva. Three-phase Alternators made by the Allmänna Svenska Electric Co.

work in sets of three, one to each phase. Each furnace, therefore, receives single-phase current at 6,000 volts, fifty periods per second.

At Gelsenkirchen there are twenty-four such furnaces, each taking 400 kw. at 4,000 volts.

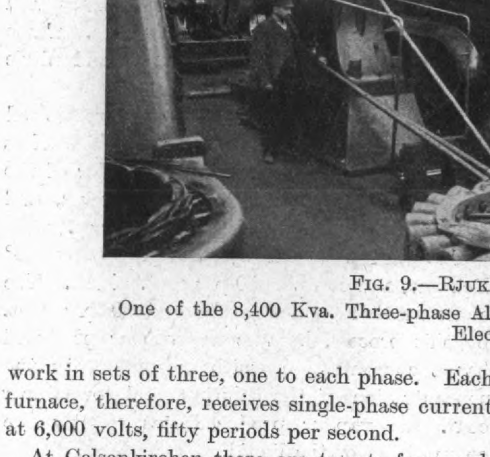

FIG. 10.

The arcs are started by means of copper starting-knives, which can be approached to within a few millimetres at the bottom, when the two horns come together. When the arc has been started, these starting-knives are withdrawn, and the larger space between the electrodes is then sufficient to let the hot air from the *tuyère* pass through freely. The starting-knives last twenty hours, whereas the main electrodes, which are of steel and water-cooled, last 200 hours.

The works of La Nitrogène Cie, at La Roche-de-Rame, Hautes Alpes, France, have nine Pauling horn-arrester furnaces of 600 horse-power each in operation, and nine more of 1,000 horse-power each are being added.

The general lay-out of the plant is shown in Fig. 11, and it will be noted that the furnaces are arranged in sets of three, one furnace to each phase.

The fresh air for the furnaces is supplied by a 250 horse-power turbo-compressor running at 3,000 revolutions, and before it gets to the furnace *tuyères* it passes through a preheater. The air travels through the furnace at 1,200 feet per second.

When the gases come from the furnaces their temperature is about 1000° C., and the nitric oxide content 1·15 to 1·5 per cent. They first pass through the preheater, and give up some of their heat to the fresh air going to the furnaces.

The gases then pass through the two cooling towers which are outside the furnace-house. Each of these towers is 16 ft. in diameter and

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40 ft. high, and filled with firebrick. When the bricks of one tower have become hot the gases are switched over to the other tower. Fresh air is then drawn through the heated tower by means of the chimney (85 ft. high), and the brickwork in it is thus cooled.

The gases are sucked out of the cooling tower by a 15 horse-power fan and forced into the oxidation tower, which is built of reinforced concrete, and measures 33 ft. diameter and 75 ft. high. Here, the temperature having fallen to 600° C., oxidation to NO_2 goes on rapidly.

From the oxidation tower there are two pipe-lines, and one takes some fixed gas and air back to the furnaces, where it is passed through the central passage and comes in contact with the freshly fixed nitrogen at the top of the arcs. In this way, the fresh gas is cooled without being diluted.

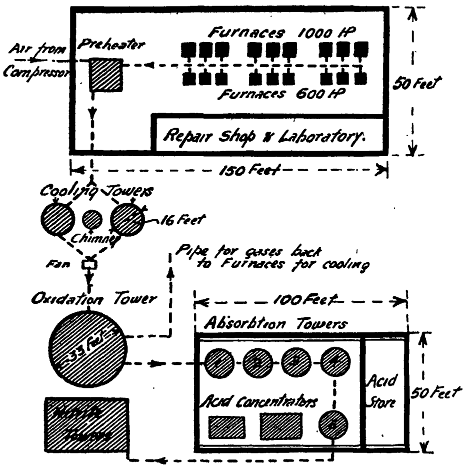

FIG. 11.—THE LAY-OUT OF THE WORKS BY LA NITROGÈNE CIE, FRANCE.

A second pipe-line of aluminium takes the remainder of the gases to the absorption towers, each of which contains 250 tons of stoneware packings. The gases pass from 1 to 5, whilst the water gradually accumulating more and more acid, flows in the opposite direction, namely, 5 to 1. *Montejus* operated by compressed air raise the solution to the top of the different towers.

The concentration of acid at bottom of No. 5 tower is about 5° Beaume; at bottom of No. 4 it is 8°; at bottom of No. 3 it is 15°; at bottom of No. 2 it is 25°; and at bottom of No. 1 it is 35°, which corresponds to about 40 per cent. of HNO_3.

The gases from No. 5 absorption tower still contain a small amount of NO and NO_2. They are passed through an acid filter, in which the last traces of acid are condensed, and then pass to the nitrite towers. These contain sodium-carbonate solution, and the gases react with it to form sodium nitrite, having a concentration of 20 per cent. This is submitted to evaporation, the hot furnaces gases being used for the purpose, and white sodium-nitrite crystals are obtained, containing 95 per cent. of nitrite and 3 per cent. of nitrate.

The nitric acid goes to the acid concentrators, in which it passes through a series of porcelain and fused quartz vessels arranged in stairway fashion. The acid is also heated by direct contact with hot gases which come from the furnace. These gases are thus charged with water and nitric acid vapour.

To condense the acid the gases are passed through a cooling coil of stoneware, which offers a large cooling surface. The remainder of the gases then pass to the oxidation tower, and mix with those coming from the furnace.

The acid obtained by the process is 36° Beaume, and contains 50 per cent. HNO_3. The concentration cannot go beyond 60 per cent. by this process, because the vapour produced has a concentration which increases with the concentration of the solution, and for 66 per cent. the vapour produced has exactly the composition of the liquid.

To obtain higher concentration other processes must be resorted to, and as high as 98 per cent. can be obtained.

Some idea of the efficiency of the plant may be obtained from the fact that Mr. Pauling guarantees 60 grams of 100 per cent. HNO_3 per kw.-hour of electrical energy, measured at the entrance of the electric transmission line into the factory; and also that the electro-chemical plant proper will cost about 120 francs (£5) per kilowatt.

The Southern Electro-Chemical Co. of Nitrolee, South Carolina, in the United States, has a 4,000 horse-power plant on the Pauling system for manufacture of calcium nitrate. Electric energy is generated in two water-power plants at Great Forks and Rocky Creek.

CALCIUM CYANAMIDE.

The discovery of calcium cyanamide came about as the result of a research by Dr. Franck and Dr. Caro, who were following on the lines of some previous work of Playfair and Bunsen. Their immediate object was to make cyanide of potassium for the recovery of gold from tailings, and they incidentally found that barium carbide

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absorbed nitrogen to form barium cyanamide. By using calcium carbide they obtained a similar reaction, according to the formula—

$$CaC_2+2N=CaCN_2+C.$$

It was then found that by treating calcium cyanamide with hot water it gave off ammonia according to the equation—

$$CaCN_2+3H_2O=CaCo_3+2(NH_3),$$

and this gave rise to the idea of using it as a manure.

As carried out at the Odda Works, the calcium carbide broken into lumps is delivered to crushing machines, from which it passes to mills in which it is ground fine, the whole of these operations being effected automatically in an air-tight plant so as to prevent acetylene gas being given off. It is of interest to note that the glowing mass from the calcium carbide furnace cannot be used straight away.

The powder is then filled into electric furnaces, of which, in the first installation at Odda, there are 196, each holding 300 kg.

Fig. 12 is a rough sketch of the furnace, and it will be noticed that down the centre there is a cardboard tube to provide a space for the carbon pencil. After the carbide has been filled in, the carbon pencil is fixed in position and the lid fastened down and made air-tight.

Alternating current is now switched on, and the temperature is raised to 800° to 1000° C. The cardboard tube and certain cardboard partitions which had been placed in the furnace when the calcium carbide was run in, are burnt up, and they leave spaces which allow the nitrogen gas, which is admitted under pressure, to circulate freely. Electric current is kept on for twenty-five hours, and at the end of thirty-five hours all the nitrogen has been absorbed as shown by the meter.

At Odda this nitrogen is made by the Linde distillation process, but in one of the French factories the Claude process is used.

The 196 furnaces make about thirty tons of calcium cyanamide, containing 18 per cent. of nitrogen, per day of twenty-four hours.

When it is turned out of the furnace the cyanamide looks like black clinker. After being broken up it is fed into jaw crushers, and then goes to roulette mills, where it is ground up fine for market.

It is then packed in a paper-lined bag, which is in a jute bag. For tropical countries there are two outer jute bags.

Recently, improvements have been introduced at the Odda Works, whereby with the same amount of power and labour the output has been increased from 12,000 tons to 15,000 tons per annum.

The furnaces are now being made to hold 450 kg., instead of 300 kg. Another improvement is that the cyanamide is treated with enough atomised water to reduce free carbide to less than ½ per cent.

From the point of view of engineers in this country, the installation of A. G. Stickstoffdunger at Knapsack in Germany (see Table IV.) is perhaps the most interesting. Gas is generated from cheap brown coal, and used in gas engines to generate the electric current.

Although calcium cyanamide is mostly employed as a manure, it has other uses. For

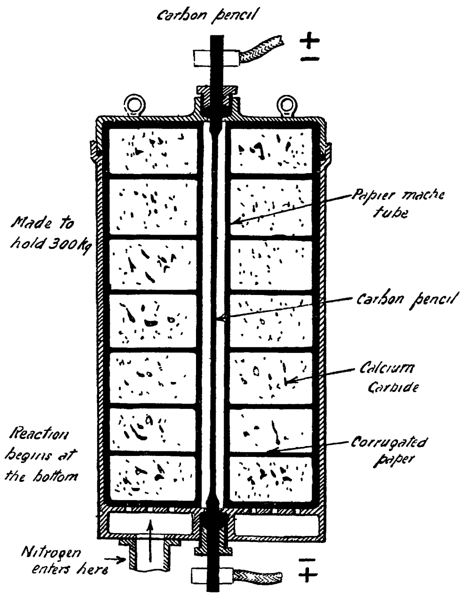

Fig. 12.—Electric Furnace for Making Calcium Cyanamide.

example, by treating with superheated steam very pure sulphate of ammonia is obtained. Also ammonium nitrate and dicyandiamide are made from it.

Explosives.

Although manures form the main outlet for the products of these electric fixation of nitrogen processes, there are other important uses.

At the Notodden Saltpetre Factory ammonium nitrate is made by bringing the nitric acid into contact with ammonia liquor from our English gasworks. The ammonia nitrate crystallises out, and when dry it contains

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35 per cent. of nitrogen, and it sells in this country at about £27 a ton. It is the principal constituent of many of the explosives for mines.

Dicyandiamide, $C_2 N_4 H_4$, which is made by treating calcium cyanamide with water, when it crystallises into broad needles or prisms, is being used for mixing with explosives. It contains 66 per cent. of inert nitrogen, and is used for lowering the temperature of the explosion.

This is of importance, because ordnance powders rapidly destroy rifling in guns on account of the high temperature. The importance of this is shown by the statement made publicly in 1905 that the twelve-inch gun Mark VIII. used on fifteen British battleships could not stand more than fifty rounds full charge.

Nitric acid is of course the main constituent of gun-cotton, dynamite and smokeless powders, etc., and at the present time we are mainly dependent on overseas supplies of raw material from which to make the acid. In case of war we should undoubtedly be in a very serious position, for whereas most Continental countries have plants for the fixation of nitrogen from the air, this country does not make a single ounce.

It will be remembered that at the time of the Napoleonic wars the French had difficulty in obtaining saltpetre with which to make powder; it behoves us therefore not to be caught in the same predicament. A few rounds from a broadside of modern guns blows away into the air as much nitrogen as was used during the whole course of a war of the last century. The necessity of having factories where explosives can be made to any amount, and quite independently of raw materials from overseas, is therefore obvious. Even if the product could not at first compete in price with existing supplies, the fact that it was a necessary addition to our national assurance against war would justify the establishment of a works to fix the nitrogen of the air.

Various Government factories for the supply of munitions of war do not pay from a strictly competitive point of view, yet everyone recognises that they must be kept up.

Cost of Power.

It will be of interest to consider briefly what are the prospects as regards the manufacture of nitrogenous products in this country. The problem is, of course, mainly one of cheap power, but to make it worth while there must also be a large supply, because some of the furnaces take 1,000 kw. and upwards.

In Scotland there are several water powers waiting to be harnessed, and one has been investigated which will give 10,000 kw. for a capital expenditure in hydraulic works and electrical plant of £200,000, or £20 per kw. installed. It is estimated that electrical energy could be turned out for 35*s*. per kw.-year, after allowing 10 per cent. for interest and depreciation. The power is capable of extension.

In Norway electric energy is actually sold at about 20*s*. a kw.-year, or $\frac{20 \times 12}{8760} = \cdot 0275$ per kw.-hour, from which it would appear that the cost of installation is about £10 per kw. of plant, and a considerably lower rate than 10 per cent. is allowed for interest and depreciation. Of course the carriage of the products from Norway to this country is an item, but it would not be much more than the carriage from Scotland to the south of England.

We know that very large steam-power stations with turbo-generators can be built for about £10 a kw. of plant, because the last extensions at Manchester cost only £12 per kw., as shown by Mr. Pearce's (the chief engineer) figures.

	Per kw. installed.
Generating machinery, turbine condenser, alternator, etc.	3·75
Boilers, economisers, superheaters, steam-pipes, coal and ash conveyors, foundations, etc.	2·25
Switch-gear for generators and feeders	·55
Buildings, with accessories	5·05
	£12·05

In "Heavy Electrical Engineering," Mr. H. M. Hobart, after carefully considering all the details of a typical steam-power station, comes to the conclusion that "The complete cost of a station well designed on modern lines for an output of over 100 million kw.-hours per year need not exceed £10 per kw." With steam turbo-generating units of 25,000 kw., which are now being made, there is no reason why the cost per kw. should not come down as low as for Norwegian hydro-electric plants. Further, if instead of burning the coal in boilers it is made into gas and by-products are recovered, it seems likely that we shall be able to generate electricity as cheaply as the average for Norway.

To show what can be done by a producer-gas power plant, the following estimate by Mr.

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Chorlton, of Messrs. Mather & Platt, is of interest:—

PRODUCER-GAS ENGINE POWER-STATION FOR 3,000 B.H.P.

Capital Costs:—	£
Four 1,000 B.H.P. gas engines complete; coupled to four electric generators starting air compressor; gas, air, water, and exhaust pipes; and water pumps	21,850
Buildings, engine foundations, crane and silencer	2,770
Exhaust heat boilers	1,600
Switchboard and wiring	1,500
Water tank and cooling tower	400
Capital Cost	£28,120

This is equal to £7·03 per B.H.P., or £10·545 per kw.

Running Costs, on the basis of 300, 24-hour working days per annum—	£
Oil, waste and stores	650
Repairs, rates and taxes, maintenance, insurance, etc., at ·01 pence per B.H.P. hour	900
Wages—Three shifts of one man at 40*s*. " " " one man at 35*s*.	585
Interest and depreciation at 10 per cent.	2,812
Total Running Cost per annum	£4,947

Assuming the interest and depreciation to be only 6¼ per cent., the total running cost is	£3,892
The capital cost of a Mond Producer Plant capable of giving gas for 3,000 B.H.P. is	£13,200

The Running Cost of a Mond Producer-Gas Plant is—	£
9,600 tons of shale	Nil.
900 tons of belt pickings	Nil.
1,500 tons of waste slack, at 4*s*. per ton	300
600 tons of washed slack, at 8*s*. per ton	240
Maintenance, including rates, taxes, labour (including packing), steam-power, repairs, stores, etc., at 2*s*. 6*d*. per ton	1,500
Sulphuric acid, at 35*s*. per ton	665
Interest and depreciation at 10 per cent.	1,320
Running cost per annum	£4,025

The By-Products would sell for—	£
Ammonia sulphate, at £12 per ton	4,560
Tar, at 15*s*. per ton	180
Value of gas not included	—
Credit per annum	£4,740

Leaving a net profit of
£4,740 less £4,025 = £715 per annum.

The net cost of energy, assuming interest and depreciation on station, at 10 per cent. is . . . . £4,947 less £715 = £4,232
This is equal to ·047 per B.H.P.-hour, or ·070 per kw.-hour.

The net cost of energy, assuming interest and depreciation on station, at 6¼ per cent. is . . . . £3,892 less £715 = £3,177
This is equal to ·035 per B.H.P. hour, or ·052 per kw.-hour.

This ·052 is for 300 days of 24 hours, but for the full number of hours in a year it becomes ·043*d*. per kw.-hour, or 31*s*. per kw.-year. If this can be done with 1,000 horse-power gas engines, then there is considerable hope for the future when the internal combustion prime mover is made in as large sizes and as cheaply as steam turbines.

At the present moment, so far as fuel power-stations are concerned, the position appears to be as follows.

For large prime movers of, say, 6,000 kw. and over, the steam turbine is in an unassailable position. It is true that the large gas engine has been made in units of several thousand horse-power, but on account of its slow speed and its cycle of operations the size for a given power is very large as compared with a steam turbine. Its weight and price are greater, and the cost of foundations and housing accommodation very much greater.

The gas turbine, or the gas *plus* steam turbine, would solve the space difficulty, but although much has been written on the theory, and some work has been done experimentally, this form of prime mover is still in the air.

As regards the production of steam and of gas for the above-mentioned prime movers, it must be admitted that the method of burning coal on fire-grates is less efficient than making gas from the coal and recovering the ammonia, etc. Also it is necessary to admit that there are mechanical limitations to the sizes of ordinary steam boilers as at present constructed.

On the other hand, gas-producer and engine plants cannot yet be considered altogether satisfactory, because the gas is so variable in quality. When steam is generated there is no doubt about the product.

With gas, on the other hand, there is no absolute certainty as to what its quality will be. It depends on the coal, on the condition of the apparatus, on the attention given by the workmen. If attempts are made to increase the yield of the ammonia, then the gas is likely to be poor, and if the gas is of good quality, then the by-products are apt to fall off.

A slight change in the kind of coal, and the whole of the gas apparatus has to be readjusted, and in the meantime the gas engines may have dropped to half power. On the other

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hand, with a steam boiler a change in the quality of the coal makes very little difference. The steam coming away is always of the same quality, however much the fuel may vary.

The Johannesburg fiasco is still fresh in our minds, but before that there had been similar troubles in large gas-power installations in Spain and elsewhere. As compared with the steam boiler, the large gas-producer is still a faulty piece of apparatus, although it is being improved. On the other hand, the present type of boiler is not above criticism, for in size it has not kept pace with the steam turbine prime mover. For example, at the Lot's Road power-house there are eight boilers for each of the 6,000 kw. steam-turbo generators, and the cubic space occupied by the boilers is about five times that occupied by the steam-turbine set.

In the near future, steam-turbo generators will be of 20,000 kw. and over—one of larger size than that is now under construction by Parsons & Co.—and as the size of the prime mover increases, this space difficulty of the boilers also increases. It is absurd that one turbo-generator should require a dozen or so boilers to supply it with steam.

A solution of the problem is the manufacture of the coal into gas with the recovery of sulphate of ammonia, tar, and oils. Then the gas must be burnt in much more efficient boilers than those at present in use.

Hitherto gas-fired boilers have been of very low efficiency, say, somewhere about 50 per cent., but with the new method of Professor Bone and Mr. C. D. McCourt an efficiency of over 90 per cent. is attainable. The experimental plants at Leeds and at the Skininygrove Ironworks have demonstrated this beyond a doubt.

The method depends primarily on mixing gas and air together in the exact proportions for complete combustion; then forcing the mixture under pressure through tubes which are packed with pieces of refractory material. The mixture is fired at the outlet end of the tubes and strikes back to the entrance end. The flame quickly raises the refractory material to an intense heat, and complete combustion of the mixture takes place in about the first six inches from point of entry. The combustion having been completed, the remainder of the material acts as a baffle towards the burnt gases as they traverse the tubes at high velocity, causing them to impinge repeatedly on the walls of the tubes. The evaporation is so rapid that the scaling troubles met with in other types of multi-tubular boilers are completely obviated, the scale being automatically shed in thin films about $\frac{1}{30}$ in. thick as rapidly as it is formed.

The core of the material is maintained at a high temperature, but when it comes in contact with the walls of the tube it is so rapidly cooled by the transmission of heat to the water that it only attains red heat.

A boiler erected on this principle at the Skininygrove Ironworks, Yorkshire, in November last, had the following dimensions: 10 ft. diameter and 4 ft. from back to front, 110 tubes, of 3 in. internal diameter packed with fragments of firebrick. The gas supplied from Otto Hilgenstock coke-ovens is mixed with little more than its correct proportion of air, and the mixture is forced into the tubes at about 2 in. water-gauge pressure. The evaporation is 5,500 lbs. of water per hour, and before being taken over by the Skininygrove Ironworks Co., it was run for a month day and night.

When one considers that a well-known boiler, to evaporate 3,140 lbs. of water per hour, occupies about 23 ft. by 13 ft. by 15 ft., it will be seen how great a saving there is in space.

On February 21st, 1912, Mr. Ernest Bury, M.Sc., wrote that the

"Boncourt boiler which was started up on November 7th last, has continued to work very satisfactorily; its working is almost entirely automatic, and is included in the routine work of the exhaust-engine men, who have eleven running machines under their control.

"The boiler has been off for inspection of the tubes, which proved to be clean and free from scale, a fact which I attribute to highly rapid ebullition. During the length of time the boiler has been at work, we have had no trouble with priming; at all times the steam having been perfectly dry.

"The average temperature of the waste gases leaving the plant has been 78°–80° C., which is ample proof of the boiler's efficiency.

"Generally, I consider that the boiler has come up to expectations. It is certainly the cheapest method of raising steam which has yet been devised."

Sir William Ramsay's Proposal.

The proposal to burn the coal *in situ* and bring the gases to the surface, when the ammonia, etc., can be extracted and the gases utilised for power, has attracted a good deal of attention.

That the coal when fired will keep alight for years and give off useful gases is quite well known. In New South Wales there is a seam of coal which has been alight for many years, but it is near the surface, and the air can get

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down fairly easily. With the deep seams of this country special provision would have to be made.

For burning out thin seams in old collieries the scheme is very attractive, because shafts already exist, and there are many seams which are too thin to work in the ordinary way. The limit for economical working appears to be 12 ins. to 15 ins. Lidgett Colliery, near Barnsley, worked an 18-in. thick seam for many years, but it closed this year. There are, however, several other collieries in Yorkshire working seams in the neighbourhood of 15 ins. thick; one colliery near Wakefield having a seam 16 ins. thick. In these very thin seams the men have to go along the gate roads laid on low trucks, face downwards, and they propel themselves forward with their toes. It really is surprising that men can be found to undertake such work, and no doubt, as time goes on, it will become more and more difficult to get men for this work. Of course, these very thin seams can only be worked when the coal is of very good quality and prices are good. We may take it, therefore, that Sir William Ramsay's suggestion has plenty of scope in the seams of under 15 ins. thick, of which there are many.

There are also many pits which contain the particular coal known as "cannel," which is specially suitable for making gas. A case in point is the Leen Valley coalfield of Nottinghamshire, where the seam known as "tophard" will be worked out in twenty years. Now the top part of this seam consists of inferior cannel coal, and since the gas companies took to producing low illuminating gas and enriching it with other materials than cannel, practically none of it has been raised to the surface.

In the five collieries of the Leen Valley, namely Hucknall, Lenby, Annesley, Bestwood, and Newstead, there are millions of tons of cannel coal, to say nothing of slack left from the seam of top hard coal and a great deal of timber.

The shafts are already down and roads made, and supposing that lower seams prove unremunerative, then all this cannel coal could be burnt out for a supply of gas. There are certainly 15,000 acres of such coal within 120 miles of London.

Equalising the Load.

The problem of utilising the electric energy of power-stations at periods when such stations are working on low loads is beginning to attract the attention it deserves. The ideal for any power-house is to secure a load of 100 per cent. load factor, and there is no doubt that if greater efforts were made in this direction the price of power would come down considerably.

The valleys have been filled in, to some extent, by power and traction loads, but as these also have to be supplied at the same time as lighting the result was not as beneficial as it was thought it would be.

Now an electro-chemical or metallurgical proposition is quite different, because such plants can often be shut down during the twenty-four hours for an hour or two, the load can therefore be adjusted to just fill up the valleys.

The Yorkshire Electric Power Co. was early in the field with this method of working, in connection with the carbide of calcium plant at Thornhill. It is of interest to note, by the way, that this power company is supplying electric energy to fifteen collieries.

At Legnano a nitric acid plant of 4,000 kw. has been at work for some time past, which operates only during the night and certain hours of the day, when power is supplied at a cheap rate from the hydro-electric station by the Società Lombarda per Distribuzione dell' Energia Elettrica. Current is supplied by the power company at 50,000 volts, and, although the price charged does not transpire, it is evidently at a figure that enables the process to pay, because an extension of 9,000 kw. is being installed.

A proposal that is being seriously considered at the present time in India is the utilisation of the water-power from an irrigation dam for the manufacture of manure. Owing to irrigation requirements, electric energy will only be available for nine months in the year, but that will not militate against the manufacture, as nitrogen fixation furnaces can be shut down and started up again at any time. The use of water from irrigation dams to manufacture manures for the farmers gives a double benefit, and there are many places in the Colonies, and in Australia in particular, where such a scheme is feasible.

The Indian scheme is for 30,000 horse-power, and it is said that 37,000 tons of calcium cyanamide, containing 18 to 20 per cent. nitrogen, can be produced in the nine months with that power.

Conclusion.

We, as a nation, are sadly behind Continental countries in the exploitation of the electro-metallurgical field. It is all very well to start manufacturing "when the business has steadied down," but generally by that time the best has been taken out of it. The processes become

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ringed round with patent rights, for naturally the master patents go to those who first commence to exploit a process commercially.

In the fixation of nitrogen nearly all the pioneer work of the laboratory stage was done in this country by Dr. Priestly, Lord Rayleigh, Sir Wm. Crookes, McDougall and Howles, etc. The actual exploitation on a commercial scale has, however, been effected by a few Norwegian and German engineers, and the centre of gravity of electrical enterprise at the present time appears to be in Scandinavia.

It is high time for the engineers and business men of this country to go into the matter to see why it is we are lagging behind, and especially to look into the question of cheap power supply. Above everything else, a progressive industrial country wants cheap power, whilst at the same time conserving its resources. We have carried municipal trading in electricity further than other countries, but have very little to show for it. There are a number of municipal plants, run by committees of amateurs who know nothing about the business, and who frequently have not the sense to pay decent salaries to engineers who could tell them. What chance have such plants of generating cheaply?

The big things of electrical engineering are now being passed over because we lack cheap power, and this is especially the case in electro-metallurgy. Within the next generation or so all previous work in electricity will look small against it, for the future is certainly for the electro-chemist and electro-metallurgist.

DISCUSSION.

The Chairman (Sir William Ramsay) said that Mr. Kilburn Scott had given a very complete survey of the field covered by his subject, and the paper provided one of the best accounts available at the present moment. As the author had said, the process began with Dr. Priestley, and, later on, with Cavendish. It might be interesting to refer to the amount of work which Cavendish expended in turning the handle of his electrical machine; he and his assistant turned it for three weeks—the speaker could not say with what pauses—in making a few grains of nitrate, presumably of sodium. Turned into kilowatts, the result would be very low. On the question of the original patents, it did not appear to be generally known that Professor P. Guye, of Switzerland, was the original patentee. The whole problem turned upon the sudden cooling of the hot gas, and M. Guye patented that idea and also the appliances by which it could be carried out, the gas passing out of a confined space into a wide space. M. Guye took out his patent about 1898, before anyone had troubled about the matter, and therefore, even if still valid, they could now only have a short time to run. Again, it was M. Guye's furnace which was now described as Schonherr's, the latter being simply an imitation. Sir William had seen M. Guye's furnace running in Switzerland many years ago, and he had difficulty in understanding why Dr. Schonherr was allowed a patent, unless upon the ground of small modifications. Another point upon which he would comment was the difficulty in relation to deliquescence. Originally the nitrate of calcium could not be handled, as it turned wet when exposed to the air. It was Dr. Messel who suggested the making of basic calcium nitrate, and he had made a free gift of the suggestion to the Norwegian Company. Without such aid the company would have had trouble with their manure; it would have been utterly unworkable, as it absorbed moisture as quickly as chloride of calcium itself. Some years ago, at the Society of Chemical Industry, Professor Guye had spoken of the advantage of bringing together the two methods of fixing nitrogen, namely, the direct method of Birkeland and Eyde and the indirect method of Franck and Caro. The method used by Linde to fractionate liquid air gave pure nitrogen, and at the same time it also gave oxygen. Conversely, the combination of nitrogen and oxygen by the other processes gave a much better yield if the amount of oxygen were increased. The improvement in the yield, he believed, amounted to 25 per cent. It would, however, scarcely pay to use liquid-air plant to get pure oxygen for the purpose of mixing it with the ordinary air so as to intensify the amount of oxygen, the cost of liquefaction covering the gain. But if the two processes were proceeding simultaneously, one requiring pure nitrogen for the Caro-Franck process, and the other requiring oxygen which could be mixed with air so as to enrich it, Sir William believed that much better results would be obtained on both sides. With regard to Mr. Scott's estimates of power, he was unaware that power could be obtained at 20*s.* a kw.-year; he would have expected it to be rather higher. He would put forward the following suggestion with regard to the matter of raising steam. By pumping a mixture of gas and air into a sort of blow-pipe inside the boiler, and allowing the gas to mix with the steam of the boiler, practically all the heat of the gas could be utilised in generating steam, except so far as radiation was concerned. He had desired to deal with this proposal on a large scale, but opportunity was lacking, in addition to which it would probably cost some £20,000 to bring it into practical working. He was not sufficient of an engineer to say if the plan would be a great disadvantage in the case of the turbine.

Mr. A. A. Campbell Swinton did not know that it was altogether understood how it was that the gas turbine had not come to the fore. Turbines, of whatever kind, were essentially machines in which

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the actuating fluid had to come into intimate contact with the vanes and walls of the apparatus. For a gas turbine to have any advantage, the gas must be used at the full temperature obtained with combustion, a temperature considerably above that of red-hot iron. It was essential, therefore, to find a material (for a gas turbine) which would run at red-heat. No such material existed, however; machines of steel or iron would go to pieces in a very brief time. The alternative was to dilute the gas with, say, steam or water to reduce the temperatures. The temperature had to be reduced to that available with ordinary superheated steam, with resulting loss of the entire thermo-dynamic advantage of gas. Further, in order to get the full effect of burning gas with air, compression was necessary, and all methods of compressing were very inefficient. There seemed no immediate prospect of a gas turbine, and accordingly it was very important to get the best effect in the way of firing boilers by means of gas, so that the by-products from the coal could be obtained before burning it. The speaker had seen Professor Bone's boiler—the smaller size—in which steam was raised from cold water to 150 lbs. in a few minutes. The bottom of the boiler was cold, and could be touched. He understood the efficiency of this boiler was extraordinary, and that the total loss of heat was about 7 per cent. or 10 per cent., which included the power required for blowing. At the Skininygrove works it was being employed on a large scale. Dealing with the Chairman's suggestion of burning gas in the water, he would say that a vacuum was essential. An air pump large enough to deal with the products that would not condense would have to be very large; otherwise proper efficiency could not be obtained. As a matter of fact, steam turbines were much more effective at the vacuum end than at the high-pressure end. The speaker had devoted considerable attention to water-power in Scotland. There were several fine sources of power which might be harnessed, not comparable to those of Norway, but ranging between 10,000 and 20,000 horse-power kw. Unfortunately, the small scale of them made it difficult to utilise them for the fixation of nitrogen.

Mr. Walter F. Reid referred to the question of greatest importance, namely, that of cheap power. In this connection he was not sure that in this country a power could not be obtained which, from the point of view of cheapness, would compare with the power obtainable in Norway. He alluded also to the possession in this country of factories which could produce the absolutely essential material for a national defence. Some time ago, as a member of a deputation, he had waited upon Mr. Lloyd George, and had argued the importance of this country being able, independently of foreign sources of supply, to produce the nitric acid necessary for its explosives. Large quantities of this material were being made electrically in various parts of the world, and the matter was urgent from the point of view of economy and national independence; we ought not to be exposed to the liability of the supplies being cut off in case of war. The French Revolution furnished an instance. The British ships cut off the supply of saltpetre from India, and but for a chemist who stimulated the manufacture of this material from stable refuse and all kinds of organic materials, France would have been wholly deprived of saltpetre. In connection with the use of calcium nitrate and calcium cyanamide as manures, it was well to remember that nitrifying bacteria could be propagated in the soil, and the organisms which preyed upon them could be destroyed by heat. The speaker doubted if fixation of artificial manures could compete with this method. At present, however, available methods must be utilised, and it had been shown that nitrogen from the atmosphere was a marketable product and could compete with nitrate of soda. Coal was the most important source of energy in this country, and he thought the suggestion made by the Chairman at the Smoke Abatement Exhibition might be a way out of present difficulties. The production of gas in the mine itself, and its utilisation on the spot in fixing nitrogen from the air should enable us to compete on fairly even terms with material which had to be imported from a considerable distance. The plan seemed feasible, and offered a possible investment for capital now going abroad. While agreeing with the author as to the failure of certain large gas-engine plants, he did not feel that this excluded any prospect of getting larger gas engines in the future. He did not, however, see any necessity to build them so large; electric energy could be concentrated in a number of small units, which could be run economically with cheap gas. With regard to recovery of waste products from gas producers, it should not be forgotten that in fixing atmospheric nitrogen on a large scale the value of such waste products would be diminished, and the price of sulphate of ammonia would fall. In discussing large factories, the speaker alluded to the curious fact that the nitrate of soda in the lyes was a waste product; originally this nitrate was the source of the whole of the nitric acid. He rather believed that there was considerable waste going on in these factories, due to the predominance of the engineer and disregard of the chemist, who could better work out certain details. The speaker had had occasion to investigate one of the processes that had been mentioned, and had found that the gases were diluted to as much as 100 per cent., whereas one of the essential requirements of the apparatus was to keep the gases as concentrated as possible. Leakage over the furnace part of the apparatus, resulted in the air being so diluted that the actual yield was only one third of the amount of nitrous gases in the furnace immediately above the flame. Another important source of waste was the escaping gases

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from the condensation towers and chambers; the fumes that escaped formed a considerable percentage of the whole, and the chemist might be of good service in pointing out methods of avoiding such escape.

Professor A. W. Crossley, F.R.S., referred to the paper read by Lord Rayleigh in 1906, before the Chemical Society, on the union of nitrogen and oxygen by means of the electric flame; an experiment which was made use of by his lordship and the Chairman in their discovery of argon. Few present on that occasion would have realised that the true expression of its utility would be found in works like those at Notodden and Rjukan. It was necessary to visit the latter place to appreciate what was going on; to be actually in the power-house and factory to realise the grand scale on which it was being carried out. Anyone having that experience would be impressed by the great skill and scientific ability of those who had made a success of the process. Enormous engineering difficulties had been overcome; pushed aside as if they were of no moment. Mr. Reid had mentioned sodium nitrate as a waste product. That was not quite exact; the actual waste product was an approximately equal mixture of sodium nitrate and sodium nitrite. It was, however, unnecessary to manufacture any more sodium nitrite than was desired; the waste product might be calcium nitrate if it were thought fit. In the case of the Birkeland-Eyde process he had been told that the larger the furnace the better the yield.

Mr. Ernest Kilburn Scott, in replying to the discussion, stated that the Nitrogen Fertiliser Company were using the Linde process for making nitrogen, but, under the licence they could not sell the by-product oxygen. The Birkeland-Eyde people wanted the oxygen, and it certainly looked as if a combination of the two processes might, as suggested by the Chairman, prove an advantage. It was a distinct advantage to mix the two manures. The calcium nitrate was certainly hygroscopic, and if sown with the hand it made the hand very wet. Tests made, on a very limited scale, by the speaker, did show that the use of a combination of the two manures was better than employing either one alone. Several years of experimental work were necessary for an adequate test, but for applying, he had found it easier to sow a mixture of the manures than to sow either separately. With regard to raising steam by burning the gas in the water, this was, he understood, being tried in Germany. It would, as Mr. Campbell Swinton had said, be necessary to have large air pumps to get rid of the gaseous products. The steam turbine would not work efficiently without condensers, a fact demonstrated by Sir C. Parsons in 1892; turbines were a great success now, because of the application of special condensers. There were many incidental drawbacks to the employment of Scottish water-powers, arising from the opposition of those who wish to conserve the waters. No doubt power-stations might at first impair scenic effects, but in a few years nature covered up what was unsightly. With regard to the efficiency of Professor Bone's boiler, he had been assured that this efficiency was 90 per cent., and, on personal investigation, he found nothing wrong with the figures. In the case of an ordinary gas-fired boiler, such as used in steelworks, the efficiency was seldom more than 50 per cent., while for steam boilers in power-houses it was rarely more than 80 per cent. In the Boncourt boiler, it seemed that the swift ebullition of the water did not permit the formation of scale, so that less pure water could be used; with such violent ebullition any scale reaching $\frac{1}{30}$ inch fell to the bottom. The boiler at Skininygrove was one of a large number, and received no special attention. He agreed with Mr. Reid, that the chemist was a very necessary functionary in a works. That was shown clearly in the case of the absorption towers. Here the engineers' idea had been to fill them with pieces of quartz, letting the water trickle down between the pieces. The chemist rejected this practice, and directed the building-up of proper tiles or bricks, which allowed the water and gas to go only in certain directions. In the result the towers were cut down to half their former size. He was glad Dr. Crossley had confirmed his remarks on Rjukan. Large stations could be built in this country, and in this relation the speaker referred to the sixty odd power-stations in London, whereas, in his view, there should be only three or four, electrically linked together. There was no necessity for the power-stations to be in London at all, seeing that the distance of transmission was not of importance. Many large industrial towns in the United States, Canada, and on the Continent, drew their power from sources 50 miles distant. The time was ripe for the construction of large stations. The power-stations of the future would be at the coalfields. They would utilise the coal properly by making it into gas and recovering the by-products, and the generating units would be of 25,000 kw. or so. In the United States sets of that size were being used, whereas the largest sets in this country at the present time were only 6,000 kw. The power companies should be encouraged in every possible way to build, for large power-stations were absolutely essential to the supply of cheap power; and by the expression cheap power one meant rates that are comparable to those charged in Norway. Up to now the power companies had been hindered in every possible way, and particularly by those who encouraged the universal trading idea. About 75 per cent. of the municipal plants in this country want turning into sub-stations taking power in bulk from large power-stations, each many times larger than our present largest. In many of the Colonies—he could instance Australia, India, etc.—the future of the country was dependent upon water service, and large dams had been erected to conserve the water for the land. One dam in Australia was 180 feet high. These dams could develop a good deal of power, and a suitable use for this power

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would be in the manufacture of manures for farmers, who would also be using the water for irrigation. Virgin soil would grow crops for a few years because of its stores of nitrogen, but then, as in the United States and other parts, the nitrogen would be exhausted, and fresh supplies would have to be placed on the land. There was a proposal in India, at the present time, to harness water-power to the extent of 30,000 horse-power, and manufacture manures for nine months in the year, with water that would be also employed in irrigation. The furnaces which he had described could be shut down at any time for a few hours or for a longer period.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mr. Ernest Kilburn Scott, and the meeting terminated.

EMPIRE NOTES.

Imperial Exhibition.—Arrangements for holding an Imperial Exhibition in London in 1915 are in progress. A general committee of 120 members has been formed, by whom an advisory committee has been appointed, with Sir Peter Stewart-Bam as chairman, and Messrs. A. Cecil Beck, M.P., and P. T. Hannon as hon. secretaries. Lord Strathcona has agreed to act as president. The objects of the exhibition are indicated in the title. It is hoped that by it the resources of the Empire will be demonstrated to visitors and to commercial men from all parts of the world, to the advantage of closer commercial relations with the various parts of the Empire, and, generally, to the advantage of British trade. The site of the exhibition has not yet been determined upon. Offices have been taken in St. Stephen's House, Westminster.

Overseas Timber Industry and Afforestation.—In all parts of Canada the timber (lumber) industry is in active operation. In the west, many new lumber yards have been opened, while in the east, the trade, which was better in 1911 that in the previous year, is likely to be still better in 1912. So many building contracts throughout the Dominion have been let, that an unusually large demand has been made for all kinds of building timbers. In 1911 the total cut in British Columbia was 1,100 million feet, as compared with 936 million feet in 1910. But this year that amount is likely to be exceeded. An increased demand from the United States for laths and shingles has stimulated the industry in New Brunswick, so that a number of small mills are now in active operation in that province. Similarly in Australia the demand for building and other timbers is rapidly increasing. This demand has given an impetus in the Commonwealth to the question of forest preservation and afforestation. In Western Australia, for example, the Government have decided to increase the reserves of forest areas. So rich has the south-western division of that State been in hard woods, Jarrah and Karri particularly, that little effort has been made to regulate the work of timber-cutters. But it is felt that the time has come to give this important question the attention it has so long deserved, and by means of revised regulations, the increase of forest reserves, and re-afforestation, to conserve the industry as far as possible. Efforts are also being made to encourage the growth of soft woods, for which purpose an area of 4,700 acres has been selected in the Albany district for a pine plantation. In South Africa, also, the subject of forming plantations, in the Transvaal and Natal, is under consideration; while in the districts where the climate is dry, but the soil is deep and porous, it is suggested that test plantations should be made, where some of the drought-resisting gums of Australia may, on experiment, be found successful.

The Great Lakes and Waterways of Canada and the States.—An old dispute as to the use and control of the Great Lakes between Canada and the United States has been revived by the action taken by the Sanitary Board of Chicago. That important and powerful body has obtained sanction to deepen the drainage canal between Lake Michigan and the Illinois River in order to provide a waterway from the Great Lakes to the Gulf of Mexico, viâ the Illinois and Mississippi Rivers. For this purpose the United States Government have authorised the diversion of 10,000 cubic feet of water per second from Lake Michigan. Should this be carried into effect, the Canadian Government have been informed by their engineers, the main level of Lakes Huron and Michigan will be lowered six inches, Lake Erie five inches, and Lake Ontario four inches, to the serious disadvantage of the lake-shore business carried on by the Dominion. Enormous expenditure would have to be incurred to restore the depths of harbours and to maintain the canal system. The Sault Sainte Marie and Welland Canals, by which the great bulk of the wheat from the west is conveyed to the coast, and the depth of which—at any rate, in the case of the latter—it is proposed to increase, in order to allow for the transit of deeper vessels, would be seriously injured were the contemplated lowering of lake levels to be made. The importance of this canal trade may be realised by the fact that the total tonnage of vessels passing through the Sault Canal in a brief seasonal year is about four times as large as that of the Suez Canal in the twelve months of the year. Besides this, the proposal to increase the carrying power of the Welland Canal, for which purpose arrangements are now in progress by the Canadian Government, who propose to spend ten millions sterling on the undertaking, would, it is alleged, be rendered abortive.

Canadian Trade Returns.—The trade returns for the year ending February 29th of this year show that Canada is more than maintaining the progress she has made in recent years. Her total trade during the time under review is valued at 847 million dollars (£174,043,000), which represents an

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increase of 93½ million dollars (£19,212,330) over the previous year. Of this large amount, the value of the trade done with the United States was 453 million dollars (£93,082,200), of which 348½ million dollars (£71,000,000) was for imports. The increase of the latter over the previous year was nearly 70 million dollars (£14,583,300). The trade with this country amounted to just over 260½ million dollars (£53,549,439), of which 115,404,027 dollars (£23,718,000) represented imports, the increase of the latter over the previous year only amounting to about 5½ million dollars (£1,255,000). The comparison of the volume of trade done by Canada with the United States and with the Mother Country suggests some cause for reflection. It is true, the proximity of Canada and the States must result in an ever-increasing volume of trade between the two countries, as the growing prosperity of both demands new and reciprocal markets, but it may be possible for our manufacturers to obtain a larger share in the increase of Canadian business if only they will study local conditions and requirements, and will adopt more progressive means of making their products known throughout the Dominion. The recent appointment of Mr. Grigg, the former British Trade Commissioner in Canada, as head of the Dominion Government Department of Trade and Commerce, at Ottawa, should be of service towards this end.

Sugar-growing in Queensland.—As an illustration of the truth that "the old order changeth, giving place to the new," the conditions under which sugar is grown in Queensland may well be cited. It is not more than twenty years ago, if so long, that the big plantation system was predominant in the sugar-growing districts of that State. Now the leading feature of that industry is the number of small white cane-growers engaged in it, many of whom send their cane to co-operative central mills of which they are themselves joint proprietors. Sugar-cane growing has therefore passed out of the hands of the few rich planters and companies, and has become a democratic industry, worked by white labour, to the advantage, it would appear, of a large number of small holders, and also of the State. The adoption of this system has been greatly promoted by the Government, who have established central mills in suitable neighbourhoods, to which the local planter may send his cane to be crushed. So successful has this system proved, that in some of the West Indian Islands the example of Queensland is being followed, and efforts are being made to create a class of small cane-growers. The advocates of small holdings in this country may find some encouragement, by studying the conditions under which the sugar growers of Queensland are now able to carry on their work.

Native Labour in the Transvaal.—The Transvaal Chamber of Mines, in its annual report, states that the number of native labourers employed by mining and other companies on December 31st, 1911, was 195,850, as compared with 197,309 on th[illegible] same date in 1911. The numbers employed by [illegible]e Railway Police and Public Works were 14,257 [illegible] 1911, and 16,553 in 1910. Each case shows [illegible] reduction, which, though small, indicates th[illegible] increasing difficulty of obtaining native labour, especially in view of the growing demands of the mines and other industries. Amongst other causes of this shortage of labour, the Report d[illegible] attention to the competition of the Railway [illegible]ent in the Transkei for the construction o[illegible] [illegible]lway lines. The report states that "the mos[illegible] [illegible]s aspect of the labour supply of the gold [illegible] the ever-increasing cost of recruiting, and [illegible] in[illegible]ease in the wages of natives. The inevitab[illegible] [illegible]nclu[illegible]on to be drawn from the foregoing fac[illegible] [illegible] that, notwithstanding persistent efforts in [illegible] areas [illegible]t present available for recruiting purposes, the supply of natives offering themselves for work i[illegible] [illegible]dequate to meet the demand for unskilled lab[illegible]." The report concludes its reference to this subject by the important statement that the Union Government are "fully alive to the seriousness of the position, and may devise means of importing European labour for agricultural and domestic purposes, in order to set free those natives who are so employed at present for work in the mines." This may be a "counsel of perf[illegible]tion," but it indicates a possible change in t[illegible] policy of the Government of South Afr[illegible] [illegible] subject of immigration, of which th[illegible] [illegible]rested in that question will not fail t[illegible] [illegible]e no[illegible].

Delhi Town-Planning and Improvements.—It is reported that a Town-Planning Bill for Delhi will be prepared by the Indian Government and submitted to the Legislative Council in S[illegible]ptember. But already the municipal government of that city have started some important improvements. The work on the Bela, which was commenced before the holding of the Durbar, is now approaching completion. A further great improvement has been effected by turning the dense jungle lying between Tripolia Bridge and Osmanpur Road, which was full of insanitary depressions, into a fine, open, park-like expanse. The Quadsia Creek has also been filled up, and a new graded watercourse constructed. The city ditch is to be extended from the point at which it empties into the new watercourse across the Bela, and sullage water is to be utilised for irrigating an area of fifty acres which will be cropped. The course will then be used as a stored water channel. The old "Wanchaki" channel at the Nigham Budh Gate has been arched over, and the "Jhit" is being rapidly filled up, reclaiming a large area of land.

OBITUARY.

Sir John Joseph Grinlinton.—Sir John Grinlinton, who had been a member of th[illegible] [illegible]ciety since 1892, died on the 12th inst. in his [illegible] fifth

year. He served as a private soldier in the Crimea and gained a commission by his services. He had previously been employed on the Ordnance Survey, and was made an assistant engineer at the siege of Sevastopol. In 1857 he was appointed Assistant Surveyor-General of Ceylon. He soon quitted the Service and held various official posts in the island. Eventually, about 1872, he resigned the public service and devoted himself to business matters, in which he was very successful. Later on he became a member of the Legislative Council, and held other official appointments. He was Commissioner for Ceylon at the Chicago Exhibition in 1893, and in that capacity he rendered very valuable services to the interests of the island, services which were acknowledged by the honour of knighthood in 1894. At the Exhibition he made himself very popular, and was much esteemed by his colleagues among the foreign representatives and the American official staff. He went back to Ceylon for a few years, but in 1898 he came over to England, and has since resided in this country.

GENERAL NOTES.

EXHIBITION OF PICTURES BY THE "MOORE" FAMILY, OF YORK.—The Museum and Art Gallery Committee of the York Corporation have decided to hold an exhibition of the works of this famous family of artists in August next. William Moore, sen., was a resident in York, and a painter of portraits and miniatures of great merit. Five of his sons made painting their profession. Edwin and William Moore, jun., who practised as teachers of drawing and painting in the City of York, were also artists of more than ordinary ability. John Collingham Moore, Henry Moore, R.A., and Albert Moore, sought a wider field for their talents in London. J. C. Moore was a portrait and landscape painter of recognised ability; Henry Moore, R.A., a distinguished marine and landscape painter; Albert Moore's work was decorative, and he was unrivalled as an idealistic artist and colourist. It is hoped that corporations and private persons owning works by any member of the Moore family will lend them to the York Corporation for the purposes of this exhibition.

MEMORIAL TABLETS.—The London County Council have recently affixed a tablet to No. 88, Paradise Street, Rotherhithe, to commemorate the fact that it was the residence, in 1841, of Thomas Henry Huxley. At this time Huxley, then in his sixteenth year, had just come up to London to begin his study of medicine, and was acting as assistant to a certain Dr. Chandler, as a practical preliminary to walking the hospitals. This is the second house which has been marked as a residence of Huxley, a tablet having been affixed some time ago to No. 4, Marlborough Place, St. John's Wood, which was for many years the home of the great biologist. A tablet has also been placed upon No. 12, Seymour Street, Portman Square, which appears to have been for three or four years the residence of Michael William Balfe, the composer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS' SCHOLARSHIP.—A scholarship of the annual value of £50, and tenable for two years, will be offered for competition among graduates of the North-East Coast Institution of Engineers and Shipbuilders in September, 1912. The Scholarship will be awarded on the results of an examination held in Newcastle during the month of September, simultaneously with the matriculation examination of Durham University, in English, mathematics, and experimental science. Every candidate for the scholarship shall be a British subject and a member of the graduate section of the Institution of not less than one year's standing; and shall have served or be serving an apprenticeship on the north-east coast. The successful candidate shall undertake to remain a member of the aforesaid graduate section during the tenure of the scholarship; he shall attend a college or technical school on the north-east coast of England; and only under special circumstances will the council consider any application to attend a college or technical school elsewhere. Candidates for the scholarship must forward a written application on the prescribed form to the Secretary of the Institution, on or before the first day of August.

FLANNELETTE.—The British Fire Prevention Committee has recently tested some flannelette costing 8¾*d.* per yard, which was sold and invoiced as "safety" flannelette, by a large London drapery house, to representatives of the National League for Physical Education. Far from being a safety flannelette, or giving any safety against ignition or rapid flaming, this flannelette, of which some fifty yards were under test, flamed rapidly in the most dangerous manner and, in fact, practically the whole of every square yard under test was consumed within a few seconds when a lighted taper was applied thereto. The results of these comprehensive tests have now been published by the committee, in the form of an illustrated report, and the committee in its preamble say that it is desirable that the public should be protected from buying a material of the inflammable nature of which they are ignorant, and they suggest that legislation should be promptly instituted to protect against such a misnomer as "safety" flannelette, and that to sell a textile falsely as safe should be an offence made punishable by ordinary procedure, much as the sale of a false produce or article of consumption is promptly punishable. It should always be remembered that whilst there is a very great outcry if two or three lives are lost at any one actual fire in the Metropolis, the constant sequence of deaths amongst children, either entirely due to the dangers of flannelette, or due to causes in which the wearing of flannelette is the primary evil, has amounted during the last few years to about 1,200 to 1,400 lives per annum.

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Consumption of Gofio in the Canary Islands.—Gofio is a name applied in the Canary Islands to a food obtained by roasting and grinding grain. The word "gofio" comes from the Guanchos, a Hamitic people numerous in the islands before their subjugation by the Spaniards in the fifteenth century, and the food is thought to have originated with them. As different grains are used, there are many varieties of gofio. Maize, wheat and barley are commonly used, but any edible grain or seed is considered suitable, especially in times of scarcity. Gofio was originally used in a few other countries—for instance, in India—but it is not found in Madeira, the Azores, or Cape Verde Islands. Lately it has been introduced into Cuba, Porto Rico, and into those parts of South and Central America and the West Indies where former inhabitants of the Canary Islands have made their homes. The best gofio is made of 90 per cent. maize and 10 per cent. wheat, together with some salt, which, however, is not added until the food is to be eaten. If added sooner the salt seems to hasten mildew. In Hierro and Gomera, the most westerly islands of the archipelago, barley alone is used in the preparation of gofio. In the Island of Teneriffe 75 per cent. of the inhabitants subsist almost entirely on gofio, while probably 90 per cent. use it to some extent. In some localities in the country districts the natives have a peculiar way of preparing this staple article of food. After the addition of either milk or water, to obtain a doughy consistency, the mass is put in a "surrón," or the skin of a young kid made into a bag. The bag is then manipulated until the mass becomes as hard as the maker desires. Afterwards it is eaten with cheese, sardines, etc. Others prefer to eat it in the powdered state thrown into coffee, milk, water, soup, etc. Figs, salt fish, and pork form the remainder of a labourer's diet.

Production of Greenstone in New Zealand.—An important discovery is reported of a large outcrop of greenstone in an hitherto unexplored mountainous district, on the west coast of the south island of New Zealand, which is thought to be the original mother-reef from which all the greenstone found in that island is derived. It is anticipated that it will hereafter be so plentiful that its use will no longer be confined to local souvenir jewellery, but will be used for mantelpieces, table-tops, monuments, etc., and will also be exported to China, where greenstone in the form of jade is regarded with peculiar veneration. Up to the present time there has been no systematic mining or quarrying of greenstone in New Zealand, though the Maoris have obtained it from the beds of streams, using it for axe-heads and for personal adornment, and it has also been found with more or less frequency in the south island in sluicing for gold. New Zealand greenstone jewellery is very popular with tourists, though not all of it is real greenstone. It is largely used for brooches, bracelets, cuff-links, waistcoat buttons, etc. The region on the west coast where the present discovery has been made, was recently partially explored by the New Zealand Geological Survey, which predicted that large segregations of this greenstone, or mineral nephrite, would be found in the future, that undoubtedly many tons of fair quality could be obtained from this locality, and that rubies and copper ore, of which evidences were seen, may also be plentiful.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 20...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Captain H. Riall Sankey, "Heavy Oil Engines." (Lecture IV.)

Geographical, Burlington-gardens, W., 3 p.m. Anniversary.

British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. A. Cram, "Recent University Architecture in the United States."

Victoria Institute, 1, Robert-street, Adelphi, W.C., 4.30 p.m. Rev. E. A. Edghill, "Miraculous Christianity and the Supernatural Christ."

Tuesday, May 21...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Hon. J. G. Jenkins, "Australian Railways."

Asiatic, 22, Albemarle-street, W., 4 p.m. Anniversary.

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Study of Genetics." (Lecture II.)

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. J. D. Johnston, "Spring under Italian Skies."

Zoological, Regent's-park, N.W., 8.30 p.m. 1. Mr. A. Blayney Percival, "Lantern Exhibition of Game Animals from British East Africa." 2. Major J. Stevenson Hamilton, "The Local Races of Burchell's Zebra." 3. Dr. William Nicoll, "On Two New Larval Trematodes from the Striped Snake." 4. Dr. W. T. Calman, "On *Dipteropeltis*, a New Genus of the Crustacean Order Branchiura." 5. Mr. G. A. Boulenger, "Second Contribution to our Knowledge of the Varieties of the Wall-Lizard (*Lacerta muralis*)." 6. Sir Charles Eliot, "A Note on the Rare British Nudibranch *Hancockia eudactylota* Gosse."

Wednesday, May 22...Meteorological, 70, Victoria-street, S.W., 4.30 p.m. 1. Mr. C. J. P. Cave, "The Thunderstorm of March 11th, 1912, in Hampshire and Sussex." 2. Mr. Eric S. Bruce, "The Automatic Release of Self-Recording Instruments from Ballons-Sondes."

Economics and Political Science, London School of, Clare-market, Kingsway, W.C., 5 p.m. Mr. H. J. Mackinder, "The Geography of China."

Royal Society of Literature, 20 Hanover-square, W., 5 p.m. Mr. A. E. Morgan, "English Domestic Drama."

Thursday, May 23...Antiquaries, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor H. T. Barnes, "Ice Formation in Canada. II.—The Economic Aspect." (Lecture II.)

Friday, May 24...Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. D. Hall, "Recent Advances in Agricultural Science: The Fertility of the Soil."

Junior Institution of Engineers, 39, Victoria-street, S.W., 8 p.m. Mr. S. H. Hole, "Brewery Plant."

Linnean, Burlington House, W., 3 p.m. Anniversary.

Saturday, May 25...Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. Plunkett Greene, "Interpretation in Song. Lecture III.—Songs and their Classification."

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Journal of the Royal Society of Arts.

No. 3,105. VOL. LX.

FRIDAY, MAY 24, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

HOWARD LECTURE.

On Monday evening, May 20th, CAPTAIN H. RIALL SANKEY, R.E. (retired), M.Inst.C.E., delivered the fourth and final lecture of his course on "Heavy Oil Engines."

On the motion of the Chairman, a vote of thanks was accorded to Captain Riall Sankey for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, May 21st; THE RIGHT HON. LORD EMMOTT, Under-Secretary of State for the Colonies, in the chair. As his Lordship was compelled to leave before the close of the meeting, the chair was subsequently occupied by COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc. A paper on "Australian Railways" was read by THE HON. J. G. JENKINS.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, May 7th, 1912; THE RIGHT HON. SIR WALTER F. HELY-HUTCHINSON, G.C.M.G., in the chair.

THE CHAIRMAN said Mr. Burgoyne hardly needed an introduction, as he was a well-known rising politician interested in a great Australian firm of wine growers. The paper was one of a series which were to be read before the Society by experts dealing with the various products of the Empire.

The paper read was—

COLONIAL VINE CULTURE.

By ALAN H. BURGOYNE, M.P.

It is the barest platitude to say that not one of us in a thousand could, were the question put to us, state the genesis, sketch the history, or trace the development of the myriad articles with which, in the commonplaces of our civilisation, we daily come into contact. The man who invented the hair-pin is said to have made a fortune—I do not know in what century he lived! The history of submarine navigation began in the days of Aristotle, 322 B.C.—and roast pork, the story goes, was discovered by the accidental conflagration of a pig-sty. These are of the salt of knowledge—they can be extended indefinitely. To-day it is the turn of the vine—and especially its development as a beverage provider within the confines of our great Empire. Of the first knowledge that grape-juice was palatable, history tells us nothing. Tradition states that, in the days of woad and flint-head axes, a wife of Gaul, wishing to take advantage of the plenteous crop of her good man's vineyard, piled in an earthen jar the luscious bunches of fruit and placed thereon a cover—weighting it down with stones. One day, natural fermentation caused a crack in the jar, and from it the concentrating juices slowly dripped. To protect the floor a beaker was placed beneath, and this in course of time filled. The husband, returning hot and thirsty from the chase, seized the brimming bowl and took a deep draught. Whether the joy that followed compensated in advance for the morning of the next day is not related, but in this way the stimulating and invigorating qualities of the grape first came to man. At least, so tradition tells us—and this tradition pre-dates Bacchus by many a thousand years.

It is not my intention, nor indeed the reason of my being here this afternoon, to deal with the

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general history of vine cultivation or wine making. This subject has already been before your Society; my present motive is more national and Imperial. It is not worth while travelling outside the bounds of commercial enterprise in this matter. I have seen it stated that wine has, in recent years, been made in Wales and Egypt, but in neither case was it other than an experiment, more fantastic than utilitarian. Two great Dominions have applied themselves earnestly to the art of wine making —the Commonwealth of Australia and the United South Africa. The Dominion of Canada has executed spasmodic movements of more local than national interest, whilst Cyprus, a Crown possession, is comparable, as to future progress, to neither of the countries already named.

We will take the last named first in order, and see how matters have gone. Let this at once be said of Cyprus, that it is abundantly provided by nature as a wine-making island. Its situation, broken surface, variety of elevation from the sea-level up to 6,000 feet, associated with an even, dependable climate and season-temperature, render it fortunate in all that side of the science of vine culture in which nature is the governing factor. As against this, however, must be set the hopeless ignorance and sad poverty of the natives— a state in which they would seem to have existed from the very earliest time. Cyprus has always been regarded as the most eminent of the vine-producing islands of the Grecian Archipelago, and—again we must fall back upon tradition—was consecrated to Venus on account of its great fertility and vast natural riches. Of this fertility we obtain some glimpse by the statement of Pliny, who wrote: "Even at the present day we ascend to the roof of the Temple of Diana of Ephesus by stairs constructed of a single vine that was brought from Cyprus, where the vines often attain to a remarkable size." This striking and historical testimony to the profuse powers of vegetation is upheld by the size and luxurious sweetness of Cyprus grapes to-day.

The two favourite varieties of vine are the Mavro and Xynesteria (Professor Mouillefert, Grignon Agricultural College), whilst a third, the Ophthalmon, is also popular though unfortunately subject to oidium. The difficulty of growing is accentuated by the necessity of terracing the slopes, and much labour is expended annually in carrying up and replacing the top soil washed down from the hills by the winter rains. The system of pruning most in vogue is that known as the "Willow-Head" (*tête de saule*), which consists in cutting back all the shoots quite closely every year until the vine has the appearance of a pollard willow. The *raison d'être* of this custom is that anyone can be entrusted with the work—but, of course, the yield suffers greatly through the simplicity and almost brutality of the operation.

The process of wine making, once the grapes have been gathered, is just as it was many centuries ago. The berries are trodden out with the feet in any convenient spot, and the resultant "must" is fermented in porous earthenware jars holding from 40 to 60 gallons. These jars are coated with tar inside and out, and any of you who have drunk the natural Cyprus wines will have noticed, as a natural consequence, a distinct tar-flavour. Clarification of a sort is effected by constant changes from jar to jar, but, since they are not closed down for the first year, much of the wine becomes impregnated with acetic acid. Cyprus Vin Ordinaire is not, therefore, a beverage to be recommended to those travelling in the country; it is not only the worst of the wines made, but it is taken to the inns and hotels by the vignerons in skins even more highly tarred than the fermenting jars. Really drinkable wines, which are sold new, find a ready market in Syria and Trieste, and of these perhaps the favourite variety is one with the generic name, Commandaria. This name is derived from a Command of the Knights Templars established at Colossi, near Limassol, whose house still exists. Commandaria is a name given to a considerable series of sweet wines which are made from grapes half-dried in the sun, often on the flat roofs of the houses, prior to fermentation; this, it need scarcely be said, is for the purpose of increasing the saccharine strength. At a year old, Commandaria is carmine in colour, becoming paler and browner in keeping as also sweeter and more syrupy to the palate. During each of the first few years the loss by evaporation amounts to 10 per cent. The total consumable output of Commandaria is only about 50,000 gallons annually, but in bottle it becomes with age one of the first wines in the world. Indeed, so exquisite is it held to be by some, that Philip Augustus called it the "Pope of Wines." The yield of Commandaria is only 60 to 80 gallons per acre.

Next to Commandaria is the Cyprus liqueur, made from the native brandy, of which about 150,000 gallons are distilled every year. This

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is flavoured with aniseed and mastic, and is the most popular and common liqueur in the Levant. The commonest wine of the island, Mavro, represents about two-thirds of the total production, and is an inferior type of brusque Burgundy, strongly impregnated with tar. At Omodos a species of Muscat is made—this is mentioned as a matter of interest only, its quality is very limited.

Viticultural expansion, apart from the difficulties with the growers, is hampered by an arbitrary and complicated system of assessment of the duty payable upon all wines—good, bad or indifferent, and whether sold, consumed or thrown away. It is supposed to represent a duty of 12 per cent. upon their alleged value.

I have no figures of recent date, viticulture not being thought worthy of mention in any of the annual reports of Cyprus now issued. The following figures suffice, however, to show the progress of wine making in this island—the demand being mostly stimulated from Austro-Hungary.

1878–84.	Average production	1,770,000 gallons.
1884–90.	,, ,,	2,490,000 ,,
1890–96.	,, ,,	3,100,000 ,,

From Cyprus we take passage direct to Canada, and frankly must the confession be made, the writings and chronicles of viticulture in our huge American Dominion are so few that practically nothing is known of its history. We first hear of grapes in the account given by the explorer Cartier, in his Canadian travels, published in Paris in 1545. In describing the St. Lawrence River, he speaks of an island at its mouth where he was not only astonished at the rich abundance of the vines but also at the quality of the grapes ripening upon them. He named it at once the Isle of Bacchus; at the present time it is called the Isle of Orleans.

Of the fitness of certain districts of Canada for vine-growing there can be no doubt. The Niagara section of Ontario, for instance, is famous for its fruit, and to the extreme south-west there is a peninsula of land between Lake Erie and Lake St. Clair, consisting of the counties of Essex and Kent (including Pelee Island) where the vine flourishes marvellously. Along the Detroit River and on Pelee Island there is extensive cultivation of grapes, and quite a quantity of wine is made. On Pelee Island alone there are 350 acres of vines, and over 500 tons of grapes have been pressed in one year by the Pelee Island Wine Company. In 1896, there were 2,000,000 vines growing in the Provinces of Ontario.

Turning to Cape Colony, we first hear of vines there on their introduction by the early Dutch settlers in 1653. Their success induced these pioneers to import in 1656 still a further supply of cuttings, and we have an account of a vintage made from a species of Muscat grape in that year.

Without desire to dwell too long upon the historical side of the development of viticulture in Africa, a few points are not without interest as tracing its history.

In 1861 brandy was made, and six years later, according to the first census taken at the Cape, there were half a million vines in cultivation in the Colony. Until this time the business and methods had been of a very rudimentary character, and the vines were regarded much as the good housewife in the west country looks after her two rows of gooseberry-bushes.

With the coming of the Huguenots, however, in 1688, a sudden development upon practical lines was made, for they brought not only a knowledge of wine making, but also a large range of varieties of grape from the south of France, including the small Muscat type of Frontignan. Let it be said here that the conditions existing in Cape Colony are, if careful selection of ground be made, ideal for vine growing, but largely owing to the indolence and ignorance of those engaging in it, the rich, flat lands were chiefly chosen for the planting of vineyards, rather than well-trained hill-sides fitted by nature for terracing and easy culture. A further fault, and one which it must be admitted is to be chronicled in other countries besides Cape Colony, was the desire evinced to obtain the heaviest crop regardless of the quality of the grape. Sterne, in his "Sentimental Journey," says—

"The man who first transplanted the grape of Burgundy to the Cape of Good Hope (observe that he was a Dutchman) never dreamt of drinking the same wine at the Cape that the like grape produced upon French soil—he was too phlegmatic for that. Undoubtedly, he expected to drink some sort of vinous liquor; but whether good, bad, or indifferent, he knew enough of this world to see that it did not depend upon his choice, but that what is generally called chance was to decide his success. He, however, hoped for the best; and in these hopes, by an intemperate confidence in the fortitude of his head and the depth of his discretion, Mynheer might possibly overset both in his new vineyard, and, by discovering his own nakedness, become a laughing-stock to his people."

Without justifying this comment, the wine produced at the Cape found immediate popu-

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larity and local favour, and this though at no time have the huge natural possibilities of the country been taken advantage of for the development of vineyards.

In 1880 there were 20,000 acres under vines, planted very closely, between two feet and three feet apart. This cultivation was, and still is, largely confined to the Western Provinces owing to exceptional climatic conditions, conditions which account not a little for the productivity of the vines in Cape Colony. The principal wine-growing districts are:—The Cape, Stellenbosch, Paarl, Malmesbury, Worcester, Robertson, Montague, Ladysmith, Prince Albert, and Oudtshoorn. These can best be dealt with if divided into two sections—the coastal section and the inland section—the first four mentioned, *i.e.*, The Cape, Stellenbosch, Paarl and Malmesbury coming under the former category, the remainder belonging to the latter.

Dealing with the coastal section, the soil is largely intermingled with granite, and the foremost vineyards—Constantia, Bottelary, Moddergat, Jonkers Hock, Paarl and Groeneberg, names well known to those who have made a study of the subject—are all planted on hill-sides and granite soil. There can be no question of the superiority of these vineyards as against those planted upon alluvial flats, for the soils here, though of great variety, are all deficient in lime; let me hasten to state that excellent results have been and are being obtained by the addition of lime as a manure.

The rainfall of the coastal districts, to proceed with their description, is altogether favourable to successful vine culture, for it ranges from about forty inches at Constantia to twenty-four inches at Stellenbosch. The peculiarity of the rainfall, which quoted in the aggregate seems very unusual, is its even distribution all through the winter to the spring, when a dry summer following ensures a careful and equable ripening with an obvious freedom from all fungoid diseases. It is quite exceptional for the grapes to suffer by the rain.

The physical condition and chemical composition of the soil of the inland section of the vineyards is unique, and accounts for their remarkable powers of production. In the first place a bed of ferruginous marl, the so-called "kalk-bank," stretches very many miles through the lowland districts of Worcester, Robertson, Montague, Ladysmith and Oudtshoorn. An extensive belt of this remarkable soil stretches right across the Colony. This marl tends to, and frequently does, change to calcareous clay, which rapidly decomposes and forms a rich, loose and deep soil, the fertility of which is not equalled in the whole of the African continent.

This statement might best be exemplified by mentioning that the average yields of the Cape, Stellenbosch, Paarl and Malmesbury districts are 570 gallons of better-class wine per acre, whilst in the lowland districts just described, the average of similar wines is 1,100 gallons per acre, and many vine-growers obtain no less than 2,000 gallons per acre regularly! Baron von Babo, a son of the celebrated Austrian authority, who devoted much time during his years of employment by the Government in the Cape to the study of this question, gives the average yield as follows:—

The coastal sections	770	gallons per acre.
The inland „	1,600	„ „ „

The heavy-bearing districts produce wine of considerable alcoholic strength, superior indeed to that of the south of France. This is from a grape locally known as "Haanepoot," which would seem to be derived from the Gordo Blanco. It is a wine possessing a pronounced flavour of Muscat, and appears to be in high favour for distilling, more so indeed than for consumption as a beverage.

In 1891, 6,000,000 gallons of wine were made, and 1,400,000 gallons of brandy, so that in that year a somewhat larger quantity than the year's production of wine must have been distilled.

Haanepoot is subject to all fungus diseases, and in consequence is less popular than the Green grape, a kind of sweet-water or Chasselas, which seems to thrive even under neglected conditions, and is suitable for a class of agriculturists not renowned for their exertions.

It is the small Muscat of Frontignan from which the famous Constantia is made. Constantia is a sweet wine of considerable merit, but these syrupy productions, which at one time were much sought after on account of their undoubted quality, have largely been killed as to favour by the growing demand for brandy, and the cheap, sweet fortified wine, the popularity of which, curious as it may seem to those appreciating good wines, is growing in every wine-making country in the world.

The fortification of carelessly made wine naturally tends to promote persistent carelessness in handling and manufacture. Without any desire to be unfair to a once prosperous industry, there is no doubt that the Cape market is largely being spoiled by the inefficient and sloppy methods of the wine maker.

The Government early recognised this failing,

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and, with a view to remedying it, purchased the Groot Constantia vineyard as an experimental vineyard and a training ground for future vine growers. Sufficient time has, as yet, not elapsed to say whether or not this move was justified, but it seems sound and common-sense in the circumstances, and we may look to very different results as time goes on.

Phylloxera, that constant fear and unfightable curse of the vineyard proprietor, was discovered in 1886 in Cape Colony and has done an infinity of damage, but replanting upon American phylloxera-resistant roots is now taking place, in the face of the prejudice and ignorance of the Dutch farmer.

To show you how little care was given to the vines at the period when the most care was necessary, the following suggestion from an experienced wine grower, writing in 1886, seems a little out of the common. He advocated the use of scissors, or the use of a sharp knife, for pruning vines, saying: "It is marvellous how vines can at all sustain the rough treatment of a club-stick or a hatchet with which the young branches are too frequently broken off!"

Table wines made from Pontac, Riesling and Stein grapes possess sufficient delicacy to warrant their manufacture upon an extensive scale, but with such local demand as at present exists in this rapidly growing country we cannot look forward to much export. Even the brandy, or Cape smoke, as it is called, is unlikely to find an outside market for some years with the present primitive methods of distillation. It may also be added that both raisins and currants are largely produced and asked for, whilst the fresh grape export trade is growing fast.

In concluding this section of my paper it is interesting to note that Professor M. P. Mouillefert, who visited Africa a short time ago, stated that he saw vines growing near Cape Town which had originally been planted in the late seventeenth and eighteenth centuries.

The continent of Australia presents many paradoxes of nature. We have all heard that its flowers have no smell, that the birds indigenous to it have no song, and this, too, is equally certain, that the first white settlers found no trace of native edible fruits.

To those who know the productivity of the country at the present time, this fact will appear remarkable, and perhaps in no single instance more so than in the case of the vine.

Speaking of the country as a whole, there can be no land in the universe with a higher percentage of acres fitted for cultivation, and, at the same time, equally fitted for the development of wine-making grapes. Thus we find that, with the white man, has come the successful growth not only of such fruits distant the one from the other as pineapples, bananas, peaches, guavas, apples, pears, passion-fruit, plums, strawberries, cherries, but also the grape in every variety and for every purpose to which it can be put.

Not a little romance surrounds the introduction of the vine into Australia. It would seem that in the years 1815–16, at the termination of the Napoleonic campaign, subsequent to the battle of Waterloo, one, Captain John MacArthur, with his two sons, journeyed on foot from district to district of those parts of Europe whence wines had already come, and where the culture of the vine was the chief feature of the countryside. This journey must have been indeed adventurous, since every high road was infested with footpads and camp followers—those bad characters and human outcasts always so common during and after a long international war.

The result of this extended tramp was a bundle of vine cuttings representative of each district visited. These were taken with not a little jubilation back to the Antipodes, and at once efforts were made to propagate them. These cuttings were found, however, after cultivation until fruit-bearing, to the great dismay of those who had collected them with so much trouble, to be in almost every case worthless.

In 1825, the Australian Agricultural Company imported a few vines from the Royal Horticultural Society, which then had its gardens at Chiswick.

In 1831, James Busby brought from Australia to England the first wine, made near Sydney in the previous year. This was placed before a number of London wine merchants, who described it as a species of Burgundy, and it says much for its manufacture that when some of it, re-exported to Sydney, was opened out there it was found to be perfectly sound.

In 1832, this Mr. Busby obtained, at his own expense, 570 varieties of vines from the collection formed at the instigation of Napoleon by the Comte de Chaptal, at Luxembourg Gardens in Paris, and from Montpelier, even then a leading centre for the scientific study of the vine.

Of these 570 varieties, no less than 362 were successfully struck by Mr. McLean, head of the Sydney Botanic Gardens. It must be remembered that these cuttings, during transportation,

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in the first place had to be kept alive, and secondly, were upon the sea for from four to eight months—for I need hardly remind you that the Suez Canal was non-existent, nor had a steamship ever rounded the Cape.

Busby sent his first selection by a convict ship by permission of the then Secretary of State for the Colonies, and packed the rootlings in cases full of damp moss lined round the sides with damp-proof paper. The man in charge found that a few of them had struck *en voyage*. He, therefore, planted them on the deck in open boxes, where it was part of the convicts' duty to water them. The method of packing outlined above is, it is interesting to recall, the same as that employed to-day. These vines were subjected to tests by Mr., afterwards Sir William MacArthur, and his first selection of 140 varieties was reduced on further consideration to twenty types as being most suitable for wine making. Sir William MacArthur planted his vineyard at Camden Park from these cuttings, and to his enterprise and careful discrimination the present high state of viticulture in the Commonwealth is in a large measure due. It is apposite to remark here that every vineyard now in existence in Australia saw its genesis in cuttings supplied from Camden Park, and Sir William was at all times careful that only the finest varieties were sent round, and rigidly excluded from his choice the heavy-bearing but inferior types which have militated in many districts in other countries against the quality of the wines produced.

It may be said here that Australia is indebted to the MacArthur family for many things besides the introduction of the vine, for it was Captain John MacArthur who imported the Merino sheep given him, it is said, by George III, in 1804, and this at a time when the exportation of Merino sheep was a capital offence in Spain.

In 1837, one Joubert is chronicled as having brought out a collection of the best varieties of the Médoc. From then onwards travellers added to the establishment of the vine, and we may leave that side of the question to consider one or two features of its development which, I think, will be found instructive if not entertaining.

Up to 1838, convict labour was almost the only labour obtainable. The blacks, who represent an unusually low stage of mental development, proved not only troublesome but possessed a mania for murder, whilst the damage done by escaped convicts in their bush-ranging escapades have made history in Australia not to be equalled by any other country. The convicts were assigned to landholders as labourers in the proportion of one to every forty acres. The difficulties of transport were enormous; there were no roads and precious little water. James MacArthur, disheartened by local conditions and the absence of skilled labour, imported six families of German vine-dressers, resulting in great advantage to the industry, and we find that in 1850 there were in New South Wales 1,069 acres; in South Australia 282, and in Victoria 164 acres of land under cultivation for vines. In 1852 a great set-back was experienced, consequent on the discovery of gold, which resulted in practically the whole of the population of the continent engaging in the rush towards the diggings, and it is no exaggeration to say that there were no terms within the comprehension and wealth of landowners which could procure labour for the development of vineyards.

Visiting the diggings during this gold boom, the then proprietor of the *Melbourne Argus*, Mr. Edward Wilson, was told by a Frenchman that Australia's greatest wealth lay in her soil and climate, which were so admirably fitted by nature for the production of the vine. It is a pleasure to say here that this newspaper has at all times strongly supported the development of wine making so powerfully advocated by the original owner.

An elaborate scheme was prepared by the Government of Victoria for reserving large areas of Crown land for agricultural education, for the establishment of agricultural colleges under skilled directors and instructors, and an offer was also made of £2 bonus for every acre planted. The educational side of the scheme received little support, but the bonus had an immediate effect, as the following shows, particularly in Victoria:—

	1850.	1859.	1872.	
New South Wales .	1,069	1,200	4,152	acres.
South Australia . .	282	2,200	6,131	,,
Victoria	164	540	5,523	,,

It is fortunate, in view of the ignorance frequently displayed by those induced to undertake vine growing by this bonus, that there was amongst them a large percentage of men possessed not only of enthusiasm and enterprise, but also of capacity. The pioneers of this movement deserve mention, among them Morris, Smith, Graham, and Caughey at Rutherglen; Bear, Blayney, and Darveniza in

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Goulburn Valley; de Castella and de Pury at Lilydale, and Best at Great Western, have all done a lot to aid the forward movement. South Australia was even more fortunate, for in addition to such practical men as Davenport, Seppelt, Auld, Penfold, Gilbert and Dr. Kelly, they had in the latter a theorist of premier worth, whose book, "The Vine in Australia," is to this day one of the most remarkable and instructive works ever written upon the subject of vine growing.

In New South Wales, the MacArthurs, Wyndham, Lindeman, Wilkinson and Carmichael are amongst the best-known names, and all those mentioned, whatever the State to which they belong, will be remembered for the courage and perseverance with which they met difficulties, of the immensity of which we, who visit Australia in the heyday of its development, can have no knowledge. It is a testimonial to the personal worth of these early pioneers, that to this day their wood shanties made from trees cut down by themselves, boards hewed out by their own personal energy, are yet to be found upon the vineyards of which they were the first men to turn a sod.

Amongst other difficulties they were called upon to face was the absence of merchants, with the consequence that a grower possessing no knowledge of business was called upon to market his own goods. It is possible that this was largely why, for many years, general farming and harvesting were combined with vine growing; in addition to this, colonial wine was practically banned in the hotels of the country, whilst under the licensing system at that time in vogue no other place for its consumption could be reached. For a time, therefore, a glut of wine was found upon the market, and the owners found difficulty in disposing of their stocks—a very different state of affairs from that existing to-day when, thanks to the appreciation of the British public, the demand for the first and most important growths always exceeds the maximum supply.

Now let me give you one or two milestones in this entertaining history.

Though small quantities of wine had reached England, as already stated, from the earliest times, its importation upon a large scale did not commence until the year 1871. Since that time the imports have merely been governed by the output of wine suitable for exportation, an extraordinary state of affairs—and, indeed, one most satisfactory—that probably has no precedent in any other industry or business.

In 1878 phylloxera was first discovered at Geelong, and to-day, thirty-four years later, we are passing through years of the greatest stress that have followed from the development of this pest at that date. Whilst on the subject of phylloxera—so that it is unnecessary again to revert to it—it may at once be said that most strenuous efforts are being made in all directions to meet the evils as they arise, and to reconstitute the devastated vineyards with resistant stock of the finest qualities.

To go back to the historical side of it, two years later, in 1880, the Victorian Government uprooted every vine in the districts affected in a vain endeavour to eradicate the insect, and the cost borne by them in this fruitless effort amounted to £80,000. In 1884 phylloxera, spreading like some death-wave across the continent, reached Bendigo. In 1898 it had seized the vast wine-producing centre of Rutherglen, and in 1901 Goulburn Valley fell a victim to its ravages. The effect upon the vineyards, once it had attacked them, is almost beyond belief. The first sign the vine grower has of his vineyard being affected is finding isolated sections of it with a few vines in it of more or less stunted growth. These patches of stunted growth spread from the centre outwards like a drop of oil upon the surface of the water, so that within one year, or at most three, the affected areas join, and the whole vineyard is destroyed. Instances are frequent where, even in full growth, and bearing large crops, the vine fails suddenly a month or more before the vintage season, the leaves withering, the berries shrivelling, the crop being lost, and the vines eventually dying. In the whole history of the soil, be it applied to little shrub or giant tree, there is no sadder thing than an attack of phylloxera upon a vineyard.

Leaving the historical side of the question, I would turn for a moment to a short consideration of the soils to be found there—the climate, the method of cultivation, and the education promoted for the future welfare of the industry.

The soils most common in the districts so far developed are alluvial, though evidence of volcanic matter, as also granite, is by no means infrequent. A most common soil, perfect for the nourishment of the vine, is the red ferruginous clay loam with the occasional white quartz so common in and around Rutherglen, and particularly on the vineyards of Mount Ophir. Indeed, the most striking features of this district are the enormous piles of white quartz all round the vineyards which have been

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thrown up from the old gold-mine workings. It is not perhaps known that Rutherglen almost weekly develops towards a prominent position amongst big townships of Australia, and is named after the birthplace of its founder, and for many years its chief publican, Mr. John A. Wallace, one of the most successful of Australian gold-miners.

The climate of Australia is, if the term may be permitted, of a most contradictory nature. It is perfect if it is certain, and imperfect in its uncertainty. There is no specific rain season, and when rain does fall—if it does, which is a matter of Providence—there is a very low average as compared with that of the vine districts of Europe. The annual average at Rutherglen is but 21 ins.; it is 40 ins. on the Hunter and Lilydale, and only 9 ins. at Mildura. The dryness of this last-named place makes it most suitable for sun-dried fruit, and the very finest raisins, currants and sultanas are produced there by scientific irrigation. This market is now so prosperous that Australia is able entirely to support herself in so far as raisins are concerned, and within the next few years no more currants will need to be imported. The dryness is a blessing disguised in one way, in that the vines will not suffer from fungoid diseases. One day of hot wind will do more to check oidium than many tons of sulphur. Black rot and mildew are quite unknown, and it is seldom necessary to spray a vineyard, so easily can oidium be kept in check.

Regarding cultivation, two methods seem general—trellis and gooseberry-bush shape. To gain all advantage possible from the Antipodean situation of the part of the continent under discussion, the rows are planted in the same direction as the most prevalent hot winds, and the distance between each root varies from 8 ft. by 8 ft. to 10 ft. by 10 ft., and even 12 ft. by 12 ft. As a consequence, the yields per acre are proportionately small in comparison with those of other countries. Australians, however, take their vine growing seriously, no nation more so, and it is a privilege to pay a tribute to their prowess, and congratulate them upon their keen enterprise where the matter of vine cultivation is concerned. Their vineyard ploughs are far in advance of those used in Europe; there have been multiple furrow ploughs in general use for well over thirty years. They use short mould-boards to lighten the draught, with the natural result that the work is far more quickly done and at less expense.

The vintage commences about the end of February, and continues through March. Labour, owing to two causes—the fact that the country is new, and that it has suffered from a superabundance of ultra-democratic legislation—is both difficult to obtain and expensive to pay. Last year, boys (which means under sixteen years of age) had a minimum wage of 6*s.* per day, and earned 7*s.* 6*d.* on piece-work per day in south Australia, and it can safely be said that at the present time Australia as a country is the paradise of working-men. Without entering into a controversial subject, which has not only split nations but has dismembered parties, it is of moment to recall that all traders in Australia, under the protection which is part and parcel of the democratic egislation there, must—if their dealings be in imported goods, competing with similar articles manufactured in the Commonwealth—pay to the men they employ in their business a fixed and special wage. It is an undoubted fact that despite these tariffs, high as they are, the Commonwealth as a whole is making remarkable progress as a commercial and industrial centre.

The stemming and crushing is now done by machinery. The "must" is pumped direct into polished cement vats, where fermentation is induced and allowed to take place under the most scientific supervision, and regulated by methods of cooling which it is rare to find in the older established wine-making districts of Europe. The storage casks are erected in magnificent modern buildings. There are huge vessels holding from 1,000 to 5,000 gallons, as a rule made of oak. The reason for this storage in huge bulk is that the climate promotes unusual evaporation in puncheons, hogsheads or similar casks.

The vignerons of to-day have been forced to use their brains in the work in which they are engaged, and to meet a number of difficulties and emergencies unheard of in colder climates. Thus, the heat of early summer, arising not infrequently to 120 degrees in the shade, causes trouble in the matter of expansion; but all these things are accepted as necessary evils, and met with the fortitude based upon keen appreciation of the dangers, and knowledge of how to combat them. This knowledge, largely gained in the field of tried experience, has greatly been added to by the oundation of Government agricultural colleges, those in New South Wales being on the Hawkesbury River and at Wagga Wagga, the two Victorian ones at Longerenong and Dookie, the South Australian

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college being at Roseworthy, and, furthermore, a start has been made with a species of continuation schools, in the holding of agricultural classes, for boys leaving the compulsory State institutions.

A spirit of independence and an unusual ease in obtaining lucrative and interesting employment in a dozen different directions makes the young Australian disinclined to undergo any lengthy course, whether it be agricultural or otherwise, and this may account to some extent for the almost total failure of the Viticultural College at Rutherglen, which has since been made use of for State wards who are trained as agricultural and viticultural labourers. Furthermore, farmers and their sons attend lectures in various centres during the winter months. A course of instruction is given them by a staff of experts kept constantly on the rounds, and these lectures, it is pleasant to add, are annually better attended and the result is already being felt throughout the industry.

One word as to the future of viticulture in Australia. Irrigation is being promoted on the most gigantic scale, and indeed the largest scheme in the world, one under which half as much water again will be retained as by the Assouan Dam on the Nile, is nearing completion at Barren Jack on the Murrumbidgee. Perhaps the first essence of progress lies in the development of closer settlement. This closer settlement, however, must, by the nature of the country and its climate, be dependent upon irrigation, and irrigation as a national proposition and asset is dependent upon payable crops.

The wine produced as the result of irrigation is entirely suited for distilling, and the vines bear also the finest raisins, sultanas, and currants. The distilling side of the business has progressed by leaps and bounds since the imposition of protective duties. These amount as to the Customs to 14*s.* per gallon, and Excise 10*s.* per gallon; however much land be planted and whatever the stocks foreign spirit merchants import, it will be many years before the supply of wine is in any wise commensurate with the demand in the various directions quoted.

This, then, concludes my paper upon vine culture within the British Empire.

It is with great diffidence that I have ventured to read one, and no kindly claim to consideration is or can be made for it, as it does no more than touch upon the merest outlines of the subject; nor have I wished to burden what I have said with technical details, or scientific formulæ, reserving the time and space allotted to me rather for a discursive historical sketch of that which I firmly believe will become one of the most noteworthy and striking industries under the British flag.

I would like to conclude by quoting from a remarkable paper written by Lord Blyth, upon the subject of Vine Culture as exemplified at the Paris Exhibition of 1900. His final words seem to me so apposite to what I have said that I would not alter them by so much as a syllable. He ends a notable collection of facts in this manner—

"If, therefore, the information now presented serve to fix the attention of our own people on the nature and volume of this prodigious industry, the partnership in which should in future belong as much to the British Empire as to the rest of the world, it will be a pleasing recompense for any labour involved in its collection and arrangement. And it will be an additional satisfaction if others are encouraged to pursue further this subject of viticulture, which seems the more inexhaustible the more deeply it is studied."

[The paper was illustrated by a number of lantern slides showing the cultivation of the vine and the making of wine in Australia.]

DISCUSSION.

The Chairman said the paper was a most instructive one, and Mr. Burgoyne was to be congratulated on having produced an address so full of interest. He did not feel well qualified to discuss the paper himself because he was in no sense an expert on the subject. It was true that about thirty-six years ago he visited a vineyard then in course of being newly established near Albury in Australia, and was much struck with the energy and determination shown to get over all the difficulties that lay in the way. In those days Australian wines were somewhat under a cloud, but by the energy of those who took up the matter, including Mr. Burgoyne's family, those difficulties and prejudices had been overcome, and the wines had been successfully placed on the British market. Any slight knowledge he possessed of viticulture and wine making he acquired whilst in South Africa, and he should like to bear testimony to the great and successful efforts that had been made to improve the methods of viticulture and wine making in that country. He could testify to the correctness of what Mr. Burgoyne had said as to the fertility of the lands in South Africa which were used for vine growing. From figures that had been given to him from a reliable source he understood the production per acre in South Africa, in the coast districts, was about six times what it was in Australia and the United States, five times

what it was in France, Austria, and Russia, about four times that of Hungary, Germany, and Algeria, and more than twice that of Switzerland. In the inland districts the production was almost twice as much as that, and the amount of wine that could be produced per acre of soil in some districts was almost unbelievable. He remembered in 1903 going with Mr. Joseph Chamberlain to Graff Reinet, where Mr. Chamberlain was presented with a bunch of grapes such as was seen in the old Biblical pictures of Joshua and Caleb returning from the Promised Land, and carrying on a pole a great bunch of grapes which hung nearly to the ground between them. He hoped Mr. Burgoyne would excuse him when he said that if he had been to South Africa he would have expressed himself rather differently about the Dutch farmers. There was a story told of the late Sir William Butler that he was being consulted by the War Office about what ought to be done in Somaliland, where a certain leader called the Mad Mullah had given a great deal of trouble. Sir William's reply was, "I think you had better begin by leaving off calling him the Mad Mullah." When discussing South African agriculture it might be well to begin by leaving off calling the Dutch farmers ignorant and indolent, because that was a mistake. There were many of them, no doubt, still open to the charge, but the number was steadily diminishing, and there were amongst the Dutch farmers men who were not less progressive in their methods than the most progressive Britishers. Some of them—he did not say wine farmers, for big fortunes were not to be made in the wine industry in South Africa at present—had arrived at financial success greater than any farmer in the United Kingdom could hope to command. To mention names would be invidious; he would only ask Mr. Burgoyne to go there and see for himself, and then probably some of his friends who were so progressive and go-ahead, and had done so much for the wine industry of Australia, might think it worth their while to start in South Africa and see if they could help the South Africans to push along "the old Cape cart," and whether more could be done than was done at present in bringing the South African wines to the notice of the British consumer. Twenty-six years ago a wine farmer now and then might have used a clubstick or a hatchet for cleaning his vines, but such a practice to-day was unheard of. Opposition in days gone by to the importation into a slightly infected district of American stocks which, though they resisted, also brought with them the phylloxera, was not necessarily the outcome of prejudice and ignorance. "Cape smoke" or "dop," which was distilled in primitive fashion from "must" containing grape refuse, was not the only kind of brandy produced in South Africa. The most modern and scientific methods of distillation of brandy from sound wine had long since been introduced. Altogether he felt bound to say, in justice to the South African wine farmers of to-day, that the presentation of the case with regard to the South African wine industry in the paper was scarcely fair to them, and he attributed that, not in any sense to original sin on the part of the author of the paper, but to the fact that he had never been to South Africa to see for himself. His own principal quarrel with the South African viticulturists was that many, if not most, of them did not drink wine; they were almost all teetotalers. Not very many of them actually made the finished article. They pressed out the juice and sold the wine when ten months old to the wine makers in Cape Town and elsewhere, and it was the wine makers, not the wine farmers, who had to be held chiefly responsible for methods which Mr. Burgoyne rightly condemned. He had lived in South Africa for seventeen years, and knew the failings of the Dutch farmers and also their virtues, and they deserved encouragement rather than blame. He had received the following letter from Lord Blyth, who was most anxious to have been present that evening —"I regret extremely that a severe influenza cold confines me to the house, and prevents me supporting your chairmanship to-day, and listening to the address of Mr. Alan Burgoyne upon a subject in which I have from my youth taken a deep interest, viz., Colonial vine culture. Unfortunately the large trade which existed, at the commencement of my commercial career, in wines produced within the Empire, viz., in South Africa, has disappeared almost entirely from our imports. From 1853 to 1859 the vineyards of Europe, as is well known, were ravaged by a disease called the oidium, which facilitated the sale of wines grown in other regions. Our Colonial wines were then also further favoured by a heavy preference in the duty which ceased at the revision of the wine duties in 1860. It is extremely gratifying, therefore, to know that in the new century the whole of that large importation from the Cape had been more than replaced by the wines of an even more distant Dominion of our Empire, in free competition with the whole of the wine-producing countries of the world. Of course, I refer to Australian wines, which during the six years from 1905 to 1910 averaged 760,000 gallons annually, and in the year 1911 reached the record importation of 959,000 gallons. This is the more remarkable if it be borne in mind that the consumption of wine has steadily declined in the United Kingdom, and that the wine imported in 1911 in cask was only 9,846,844 gallons; Australian wines, therefore, being nearly one-tenth of our total importations in wood. Indeed, including the importations in bottle—chiefly sparkling wines—we find that out of every dozen bottles of wine now annually drunk in this country one bottle is from our own Commonwealth. These facts, so gratifying to Australia, are very largely due, in the first place, to the enterprise of Mr. Burgoyne's firm as pioneers, and to others who have followed their lead in making the wines known to the consumers here. We hope that the example thus set will embolden the others of our Dominions oversea to make a bid for public attention to their capabilities

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in vine culture, which not only, with our present swift communication, means the distribution of our vineyard products in the form of wine, but the shipment of grapes, both fresh and in the form of raisins. I trust that Mr. Alan Burgoyne's most interesting paper, which I have had the honour of perusing, will attract further attention to the suitability of much of the territory of our Empire for grape-culture, an industry which in Europe is only second to that of the growing of corn."

Mr. C. R. Haig said it augured very well for the political future of Mr. Burgoyne that he had so entirely dissociated his paper from puffing the goods in which he himself dealt. He had had the pleasure of the acquaintance of Mr. Burgoyne's father for very many years, and had come in contact with the wines in various ways, as chairman of juries on exhibitions and so on, and it was perfectly wonderful, as Lord Blyth said in his letter, that a stage had been reached in the consumption of Australian wines when one bottle in every twelve of the wines consumed in the United Kingdom came from Australia. The wines of the Empire now began to compete seriously with the wines received from the Continent of Europe. Mr. Burgoyne had done a great service in bringing forward the capabilities of other Colonies with regard to wine growing. He sympathised with the Chairman's remarks defending the Dutch farmers, and was glad to hear that there was a great future for the wine of South Africa if those concerned in it would only follow on the lines which had been laid down with such science and perseverance by the firm to which Mr. Burgoyne belonged. The British people would do well to give Australian wine, and wine grown in other parts of the Empire, a trial as against wine grown in other parts of the world. When chairman of a jury of the Franco-British Exhibition he saw some of the finest specimens of white wine, exhibited by Messrs. Burgoyne, which he had ever seen from any country of Europe or the rest of the world. The fact that such wine had been produced in the course of half a century was a wonderful tribute to the energy of the British race. It should be mentioned that the progress had been made without any protection whatever. When the protective duty was removed from South African wines the consumption fell very largely, but that had been more than replaced by the wine from Australia, which had made its mark here without any protection whatever, and in competition with the whole of the wine-producing world. Therefore it was greatly to the credit of the wine producers and the merchants to have achieved the results they had done, situated as they were 12,000 miles away, and competing with wines coming only a few hundred miles from the Continent of Europe.

Mr. C. du P. Chiappini (Trade Commissioner for the Union), after explaining that he was authorised to speak on behalf of the Government of South Africa, said he must thank the Chairman for his able and sturdy defence of the reputation of his countrymen, and assured him that his action would be very much appreciated in South Africa. They had listened with interest to what Mr. Burgoyne had to say in his paper. He devoted a considerable portion to praising the methods adopted in Australia, while a very large portion of his paper was devoted to condemning the methods in South Africa of the wine producers, his remarks being of a personal nature. While quite agreeing with every word stated in appreciation of the Australians and their methods, the speaker entirely disagreed with the author's remarks having reference to his countrymen. In more than one portion of his paper, Mr. Burgoyne accused the South African wine farmer of ignorance and indolence and prejudice. He would be failing in his duty and lacking in manliness if he allowed these remarks having reference to the Dutch farmers to go forth to the world unchallenged. The speaker was not annoyed, but felt grieved that Mr. Burgoyne should have thought fit to speak of his countrymen in those terms. South Africans were, however, used to imputations of this description, and did not accept them seriously, as it was quite clear that Mr. Burgoyne knew nothing about the conditions prevailing in South Africa: otherwise he would not have made those remarks. The South African wine farmers, far from being ignorant or indolent, were a highly intelligent section of the community, well educated, and knowing their business. They were thrifty, but lived in fine homes of beautiful architecture in lovely surroundings, which in itself would inspire them to rise to a high level. They were descended from a race of gentlemen, and were the aristocrats of South Africa; they provided good education for their children; their sons had filled high places on the judicial bench, which they had adorned with credit to the Empire, while some of them had held distinguished positions in public life, some being Ministers or ex-Ministers, and others prominent members of legislatures of the country; many of them were also leading barristers or members of the medical profession. Turning from the sentimental side, the speaker dealt with the purely commercial side of the question. The South African wine farmer catered for his local market, and had found this more profitable in recent years than endeavouring to create an export trade. South Africa produced over 6,000,000 gallons of wine per annum, which was consumed in that form, and about 1,500,000 gallons of brandy, which was chiefly made from wine. Roughly speaking, South Africa produced about 12,000,000 gallons of wine per annum. South Africa was a large mining country, besides which there were other good paying industries, such as the production of ostrich feathers, mohair, maize, wool, wattle bark, and other industries. The persons engaged therein did not produce wines, but might require them. This constituted the wine growers' local market. The wine farmer found he could get a better price in

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South Africa than shipping it to this country; and thus catered for the best paying market. This did not indicate ignorance or indolence. If we examined the figures of the British wine trade we should find that the total imports of wines into the United Kingdom was about 13,000,000 gallons per annum. Supposing South Africa was to increase its output to the extent of about 20 per cent. only, and export that quantity to the United Kingdom, how would that affect the price of wines in England, the quantity of wine produced in South Africa being nearly equal to the consumption in England? This increase of 20 per cent. on the South African production would equal about three times the amount of wine now imported from Australia. Only recently he made a report to the Government pointing out that the price of wines had gone up in England, and supplied them with all information connected with the wine trade, and also requested them to forward commercial samples to be submitted to the trade with a view of ascertaining its commercial value. The Government placed this report before the Chamber of Commerce, Cape Town, who, after careful consideration, replied that they were well acquainted with the conditions prevailing in England in connection with the wine trade, and that the price obtained in South Africa was better than that offered in England, and for this reason they could not see any good results would follow if they forwarded the samples. Mr. Burgoyne made a great mistake if he judged a country by its export trade only. It might interest him to know that France, the largest wine-producing country in the world, whose annual production totalled 1,250,000,000 gallons of wine per annum, only exported to all other countries of the world about 4 per cent. of its total output; while Italy, the second largest wine-producing country in the world, with a production of 700,000,000 gallons, exported even a smaller proportion. These countries also catered for their local trade, it being remembered that all countries imposed a heavy duty on wines crossing their borders. The speaker did not wish to maintain that it was not necessary to create an export trade, but nobody knew better than Mr. Burgoyne what it would cost to do so, and how little benefit the producers would receive from it. The consumers of Mr. Burgoyne's wines in this country might be surprised to hear that only about 10 to 15 per cent. of what they paid for the wine went to the producer, while more than 85 per cent. went to the advertising agencies, to the Treasury in the form of Customs duties, profits to the distributors, and other incidental expenses such as bottling and marketing. Mr. Burgoyne told them a great deal about what experts had done for Australia. Unfortunately the foreign experts tried in South Africa had proved to be hopeless failures. The only successful wine experts they had had were those of Colonial birth. Mr. Burgoyne also enlighted them considerably as to the methods and results of wine making in Australia, and, while again agreeing with him that the Australian wine growers deserved every credit for having produced a commercial type of wine, the speaker must say that its quality was not such as to induce South African growers to aim at it as a model. It was well known to all those connected with the wine trade that the South African wines, as consumed in the clubs and hotels or in private life, were of a decidedly better quality than Australian wines. This was the verdict of their own judges in England. The result of the awards at the Grocers' Exhibition of last year, when a London firm (Messrs. Westmacott & Co.) exhibited under the Colonial Section a few small lots of Cape wine which they had in stock, proved that in every case where Cape wines came in contact with Australian wines, the South African article took the superior award—that did not show ignorance or indolence. The South African wine farmers, so hardly dealt with by Mr. Burgoyne, were not wholly to blame for the class of wine they made. They only grew the grapes and sold the wine before it was ten months old to the wine dealers, who manipulated it and placed it on the market. The wine farmer was a business man; he made the class of wine which the dealer required; the latter bought what he could sell. At all events, if anybody was to blame for not having created a market in this country for South African wine it was not the wine grower, but the dealer. It was the duty of the latter to find markets and the duty of the former to produce the article demanded. To produce a very high-class wine necessitated a considerable increase in the cost of production, and there was little demand in South Africa for high-priced wines, while the market in England was well stocked with high-priced wines from the Continent of Europe with old-established brands. In conclusion, the speaker quite agreed with Mr. Burgoyne when he pointed out the great fertility of the soil in South Africa and how easy it was to produce wines, and as he had all the means at his disposal Mr. Chiappini felt sure that under such favourable conditions Mr. Burgoyne would go out to South Africa and produce large quantities of wines suitable for this market. For the last 100 years, however, they had had critics of the methods of production of wine in South Africa, all of whom had pointed out the great natural advantages which the country offered for the easy production of wine. These criticisms emanated from a class who sold their imported wares to the farmer, and who bought his products, but with few exceptions not one had been known to devote his time or put his capital into the production of wine in South Africa. What they really wanted in the South African wine trade was a Burgoyne to find a market for their wines, and the speaker could assure him that the wine farmer in South Africa would produce what he offered to buy.

Mr. M. D'Arblay Burney said he had listened with very great interest to the discussion, as he formerly occupied the position of Viticultural Expert to the Government of Victoria. In Australia they compared viticulture with their own standards, and

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those standards were somewhat higher than at the Cape. He took it that the paper had no intention of decrying the product of the Cape, but was merely making a comparison from a perfectly natural standpoint. Mr. Chiappini had mentioned that the production of wine at the Cape was six million gallons. Mr. Burgoyne stated that the production of brandy in one year was 1,100,000 gallons. It took about five gallons of wine to produce one gallon of brandy. That showed that a large proportion of the wine in South Africa was made into brandy simply and solely because it was not of a quality that would find a market elsewhere. The opposite argument would very largely apply to the illustration comparing France as a wine-producing country. The remark that the very large production in France was consumed in the country would lead to the belief that the districts in France which produced wine for their own consumption were the rich districts, but it was really the countries that were able to produce a wine of such a value as to be recognised all over the world which had succeeded commercially. He should like to point out that when the Chairman visited Albury many years ago the methods then utilised were not the extremely high scientific methods at present in vogue in that district.

Professor Anderson Stuart said it was not ignorance and indolence on the part of South Africans, but the cost of labour. As Mr. Burgoyne pointed out in his paper, it cost a good deal of money to grow grapes, and, therefore, the grapes were grown on the flat alluvial land and produced a strong "must" and a strong wine. He was glad to hear the nice things Mr. Burgoyne had said about Australia, and agreed with what he said about the claret being often a kind of Burgundy. It was a great pity that European names had been adopted instead of Colonial ones. It would have been much better if the wines had been named after the districts. It would surprise many people to hear that in the neighbourhood of Sydney a very excellent champagne was produced. He had discovered by experience that the merchant was a very important person in the wine trade. If one went to the vineyard and asked for a quantity of wine, one was never sure of getting the best bargain for one's money. The merchant, however, knew his business and was able to buy a good wine because the bad wine was not going to keep. It was quite true that Colonial wine was in many cases banned. To this day there was a great deal of snobbery at the dinner table, and he himself was one of the snobs, because he thought twice before he offered his guests Colonial wine, as if he did so they would probably think he was a mean Scotchman! It required a certain amount of moral courage to give a man Colonial wine, and so long as Colonial wine was banned the production would undoubtedly be discouraged. He himself preferred Colonial wine for two reasons, first, because it was cheap, and, secondly, because he could use less of it and get the same effect. The dryness and sunshine of Australia produced a strong grape-juice which produced a strong wine. There was a third reason, the most potent of all, and that was that he was patriotic. He was interested to hear that one bottle out of twelve drunk in this country came from Australia, and also glad to know that the supply was not equal to the demand, as he would see to that when he went back to Australia.

Mr. P. J. Hannon thought the unfortunate misunderstanding that had arisen between Mr. Burgoyne and Mr. Chiappini was due to the fact that Mr. Burgoyne had not had the opportunity of consulting the latest reports from South Africa on the development of the wine industry. It was his fortune to be associated for three or four years with the wine industry in South Africa as Government officer charged with the organisation of what was known as the Co-operative Winery in South Africa. So far from the Cape farmer being at all backward in taking advantage of modern methods in making wine, he had brought himself not merely up to date, but very much more up to date than many people who were concerned with the manufacture of wine in Australia. With Mr. Burgoyne's characteristic modesty he did not say how much his own family had influenced the improvement of the Australian wine industry. When endeavouring to improve viticulture and wine making at the Cape, he tried as far as possible to get at the secret of the Burgoynes' success. Mr. Chiappini sent out to him a very large collection of Mr. Burgoyne's products, and the products of several other wine makers in Australia, and they did their best in South Africa to produce wines of similar types, but the South African wine people said that the South African wines of their own types were in every case superior to the samples received from Australia. He felt sure the meeting of Mr. Burgoyne and Mr. Chiappini would have the effect of clearing the air, and cementing the relations between Australia and South Africa in the future.

Mr. Robert Gray (Renter Warden of the Vintners' Company) said Mr. Burgoyne had omitted to mention New Zealand, from which some very excellent wines had come, and he thought New Zealand should not be omitted from the list of wine-producing countries of the Empire.

Mr. Alan H. Burgoyne, in replying, admitted that he had left out New Zealand, but he had also left out India, where he was told that they onc grew a bunch of grapes. He had said at the beginning of the paper that it was necessary to deal only with those countries which were developing the vine on a commercial basis, and he did not think New Zealand was doing that. He accepted the Chairman's reproof. He wrote the remarks on South Africa with the courage of ignorance. It was only possible when dealing with the product

of a country to judge them by commercial results. The Cape started wine making 200 years before Australia thought of it; and yet as the result of bad methods of cultivation thirty years ago, Cape wines had a bad name to-day; and it was owing to Australia carrying out the manufacture in a scientific manner from the commencement that they had swept the Cape wines off the markets of the United Kingdom. He was afraid Mr. Chiappini really did not say quite enough, because in dealing with the criticism in the paper he had overlooked the praise which was also there. He should never accuse Mr. Chiappini of being either ignorant or indolent, for his remarks were both interesting and far-reaching. He was very glad to have had the opportunity of seeing the national spirit so strongly developed, and very glad that it had not become a national conflict. With regard to the remark that the wine grower at the Cape only made what the merchant offered to buy, if the Australian wine trade had been developed on that basis there would have been no wine bought. Australia made the people buy what they ought to drink, and that was the only method of making business in these days of competition. He should have liked the discussion to have gone on, because no question had been raised that presented any difficulty in answering. It had been a pleasure to him to put forward a few details of what he thought was going to be a very great and very important industry in the near future.

Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D., said there was no question of the original country of the vine—that is, ever since the surface of this world had presented the physiographical features and conditions known to us at this day; and roughly we might identify it with the Persian provinces of Azerbaijan, Mazandaran, and Khorasan. It was from here as a centre that the cultivation of the vine and the manufacture of wine had been carried east and west into all the countries of the world, which had an average annual temperature of from 48° to 68° Fahrenheit, the summer temperature never falling below 66°, and the winter below 38°. The etymological facts that the Semitic, that is, the Babylonian, Assyrian, Hebrew, and Arabic names of the vine were radically one and the same, and that the European names for wine were all modifications of its Aramæan name, were of themselves a strong indication that Mazandaran was the primæval habitat of the vine, and Armenia the earliest notable seat of the brewing of wine, and market of its commerce. The Biblical myth of the drunkenness of Noah, Genesis ix. 21–5, and the Iranian myth of the accidental discovery of wine by the wife of "King Jamshid" of the "Peshdadian Dynasty" of Persia, of which Mr. Burgoyne gave, at the beginning of his lecture, a local variant,—were in their vague, epical way, a confirmation of the inferences he had ventured to draw from the derivations of the words vine and wine. The Queen was fond of grapes; she forgot for a while some she had left in a jar; and when she next looked into it, finding they had all fermented, and turned to a musty liquid, curiously tasting which, and becoming intoxicated, she tempted King Jamshid to drink some; and he also becoming intoxicated, they called the accidental brew *Zehr-i-Kush*, "the Poison of Delight," the Persian laudatory phrase in praise of wine from "B.C. 3209" until now. These myths, taken together, implied also the immense antiquity of the cultivation of the vine, and the manufacture of wine; an implication fully supported by more conclusive historical evidences. It was demonstrable from the monuments that wine was in use in Egypt from at least B.C. 3000. The immemorial wealth of Palestine in the vine was strikingly shown by the passage in Genesis xlix. 11, 12, in which, describing the prosperity of Judah, it was said—"He washed his garments in wine, and his clothes in the blood of grapes; his eyes shall be red with wine": while the estimation in which the vine and wine were held in Israel was well illustrated by the parable in Judges ix. 8-16, of the Vine being asked to be "King of the Trees," and answering—"Should I leave my wine, which cheereth God and man, and go to be promoted over the Trees?" This appreciation of wine, as one of the best of the gifts of God to man, continued with Israel to the end, as was to be seen in the advice of St. Paul to Timothy, 1 Timothy v. 23—"Drink no longer water, but take a little wine, for thy stomach's sake, and thine often infirmities." The wines of Helbon, and Lebanon, and Zeeb were in repute in all the countries surrounding Palestine; and the fames of their names gave a fragrance and a flavour to these antique brands (the first two of them he once procured from Syria), which they would otherwise lack for those whose "nose" and "taste" had been sophisticated by generations of intimacy with the vintages of France, and Spain, and Portugal. Wine was used in the religious ritual of Israel; but the priests might not drink of it while actually engaged in the service of the altar (Leviticus x. 9). This enthusiasm of Israel for wine did not blind them to the evils of the abuse of its enjoyment, only it was sagaciously recognised that gluttony was no less pernicious than drunkenness,—"the bread of wickedness" than "the wine of violence." Homer's references to wine were as instructive and interesting as those of the Bible, and seemed inspired by a similar spirit. In the Iliad, i. 462, he referred to "sparkling wine" poured on the roasting joints of victims offered to the Phœbus Apollo; iii. 246, to "joyous wine . . . in a goat's skin"; iv. 259, to "cups of dark red wine,"—and 346, to cups of sweet wine; in xi. 639 (and Odyssey x. 234–5), to Pramnian wine: and in the Odyssey, ii. 346, to "old sweet wine, divine drink,"—and 350 to "sweet wine in casks, more luscious than all the rest [in Penelope's "cellar"] save that reserved against the return of Ulysses"; iv. 622, to "heartening wine"; v. 165, to "red wine giving strength,"—and 265, to "a skin of black wine"; ix. 163, and following, to men "feasting all the day to sun-down on roasted meats, and sweet wine,"—196, to "a goat skin of

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black wine,"—and 205, to "wine in 12 casks . . . divine wine," which poured out to drink was mixed with "twenty measures of water, raising a sweet fragrance from the cup divine." Returning to the Iliad, vi. 264 and following, we found Hector adjuring Hecuba :—"Bring me no exhilarating wine, revered mother, lest it unsteady me, and I fail in prowess." But the "Natural History" of Pliny was the inspiring and splendid storehouse, "the classical place," of the knowledge of the cultivation of the vine, and the manufacture of wine possessed by the ancients; and inexhaustible so far as Greece and Italy were concerned. Beside other incidental notices, the whole of Book xiv. was given up to the subject; and every one of us practically engaged in, or responsibly connected with viticulture and vinifacture ought to know the book as intimately and instinctively as his A B C. Pliny himself protested against the impatience of such men of the experience of past generations in their own trade—the very impatience shown by the so self-called "practical men" of our present day towards classical studies. He would make note of but a few of the facts recorded by Pliny in Book xiv.; and it would be no reflection on us if after an interval of just 2,000 years we found those which he thought trivial the most significant. After, in Chapter 2 (1), stating, as quoted by Mr. Burgoyne, that the staircase of the temple of Diana at Ephesus was constructed of vine-wood, in Chapter 7 (3), he said of wine drinking, "Nothing is more healthful in moderation, nothing more harmful in immoderation"; in 8 (6), he enumerated fifty varieties of generous wines; in 9 (7), thirty-eight of foreign wines; in 10 (8), seven of salted wines; in 11 (9), eighteen of sweet wines; in 12 (10), three of second class ["deuteria"]; in 19 (16), sixty-six of artifical wines, including cyder; in 22 (18), twelve "with miraculous power," recalling the "wine of astonishment" of Psalms lx. 3, A.V. ["deadly wine" of the Psalter, and "wine of staggering," R.V.]; in 23 (19), beginning with the observation that [as in India of the Hindus, so in Greece and Rome] life is based on religion ["religione vita constat"], he tells us that it was held improper by the Romans to offer to the gods any wines derived from an unpruned vine, or one struck by lightning, etc., or Greek wines, because of their being diluted with water; 23 (22) on drunkenness was the most powerful, because the most temperate "Temperance Tract" ever indicted; and it was an apt example of how much we lost from our system of classical education being too exclusively restricted to the perfectioning of scholarship, and literary culture, and political wisdom, to the neglect of the study of the industrial knowledge and the economic arts of the ancient Greeks and the Romans, that our advocates of temperance should never have reproduced this chapter from Pliny, the sound common-sense of which was as impressive as its simple eloquence. In Book xxiii. he again treated voluminously of the medicinal virtues of wine, and quoted the popular proverb, "Wisdom is obscured by wine"—"Sapientiam vino obumbrari." The other ancient proverb of wine, "In vino veritas," was first quoted by Plato—Οἶνος ἀληθής ἐστι. All that is classical of antiquity being always modern, to the latest modernity, he now quite naturally passed from Pliny to the fourth paper by Sir Henry Trueman Wood on "The History of the Royal Society of Arts," dealing with the subject of "The Society and the Colonies," published in our *Journal* of September 29th last, because, with reference to what Mr. Burgoyne had said of John McArthur, he wished to draw attention to the fact that the Society awarded him a gold medal for his first importations of wool into this country, and another to Messrs. Starkey, Buckley & Co., of Huddersfield, for making some of it up into cloth; and they awarded a second gold medal to John McArthur in 1824, and also a silver medal to his nephew Hannibal "for the next greatest quantity of fine wool" received from the Antipodes; and there could be no doubt that, as Sir Henry Wood said, this prompt and decisive action of our Society, nearly one hundred years ago, "helped considerably in making known the (then) new and important source of supply (of wool) thus opened up" to the United Kingdom by "the Father of New South Wales." Mr. Burgoyne would also be gratified in hearing that, as stated in the aforesaid paper, this Society in 1822 offered a gold medal for "the finest wine, not less than twenty gallons, of good marketable quality, made from the produce of vineyards in New South Wales"; and in 1823 a silver medal was presented to Mr. Gregory Blaxland for wine from his vineyard at Paramatta; and in 1828 the gold one was presented to him for a pipe of wine produced on his vineyard in 1827. These were only two examples of the way in which the Royal Society of Arts has ever kept on the alert to encourage the incipient industries of our wonderful Colonies, and of the discrimination shewn by the Society in so doing; and the Colonies owed the Society a substantial measure of gratitude for this our persistent and patriotic attitude towards them. He must back Mr. Burgoyne in his criticism of the Cape wines, and he was glad of the honest indignation it aroused in Mr. du Plessis Chiappini. Mr. Burgoyne was evidently thoroughly well informed on the history of Cape wines, and could recall the fact that when the duty on Cape wines was only 2*s.* 11½*d.* per gallon, compared with 5*s.* 6*d.* on all other wines, the Cape wines were worse than ever; and that even "Constantia," naturally one of the finest wines in the world, was degraded and depraved by the fiscal favour then shewn by us toward Cape wines. After to-night he would hope that the Cape wines would be worked up to the same high standards of quality as the Australian wines, and that Mr. du Plessis Chiappini, and even he himself, might live long enough to find that between importations from the Cape, and from Australia, we should in this country be drinking, not one bottle only of Colonial wines out of every twelve we import from over seas, but the whole dozen, all Colonial, for there was

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no finer wine produced in the world to-day than the Australian. He did not speak of bookish knowledge only, but of practical, personal experience. Mr. Brudenell Carter, the eminent oculist, founded in 1871 the International Wine Society of London, and made him an original member of its committee, because he was found to have an infallible "nose" and "taste" for port wine and brandy, and for about thirty years he never missed the monthly meeting for tasting wines; and they all gave particular attention to our Colonial wines, including those of California, for America was, for the present, our greatest Colony; and he must say that Cape "Constantia," when honourably brewed, and the wines of Australia and of California, in all the essential virtues of wine, were not to be beaten by anything —"From humble Port to imperial Tokay"— that came to us from Europe; although some prejudices still remained in favour of flavours in wines which, one or another of them, we had been drinking for centuries. Throughout all time, and all countries, the witness of sound wines was to be sought in their odour, and flavour, their clarity, and colour; and all fine wines should be strong of constitution, beautiful to behold, and fragrant, fresh, and frisking:—

"Vina probantur odore, sapore, nitore, colore:
Si bona vina cupis hæc quinque probantur in illis,—
Fortia, formosa, fragrantia, frigida, frisca."

He most cordially moved the vote of thanks to Mr. Burgoyne for his paper, which had proved of two-fold merit, in its own excellence, and in its having provoked a discussion, full of reality, and of the best omen for the future of our Colonial wines. Votes of thanks to the chairmen at these meetings were not proposed, but as the only member of the Council of the Society present, he must be allowed to express their gratitude to the Right Honourable Sir Walter F. Hely-Hutchinson for taking the chair that afternoon, his occupation of it having so greatly contributed to the cordiality and marked success of the meeting.

THE HON. JOHN GREELEY JENKINS (ex-Prime Minister of South Australia), in seconding the motion, said he came from a little State where there were only 400,000 people, but where between three and four million gallons of wine were manufactured. A great deal of credit was due to the firm of Messrs. Burgoyne & Co. for the introduction and improvement of Australian wines, because after all to build up a business it was necessary to put good stuff on the market. Mr. Burgoyne spoke of the superiority of Australian wine, and Mr. Chiappini had dealt with the superiority of Cape wine. It was difficult to judge between them, and perhaps it would have been better if they had brought a dozen bottles and submitted them to the meeting, which might have acted as a jury and settled the matter! In dealing with the production of wine in different parts of the Empire, the British Government, being a strong Free Trade Government, would never think of assisting Australia by a duty, but he had pointed out to some members of the present Cabinet that in the interests of free trade the duty on Australian, South African, and other wines, might be reduced without sacrificing any high moral principles in any way whatever.

THE NEW INDIAN PROVINCES.

The recent introduction of the Government of India Bill, which contains the machinery necessary for carrying out the policy announced at the Delhi Durbar, is concentrating public attention and some criticism on political changes in India, which would doubtless have elicited more attention and discussion had their importance not been overshadowed at the time by the overwhelming personal interest of the King's visit to India. Apart from the momentous change of capital from Calcutta to Delhi, it may be recalled that three new Provinces, or divisions of considerable extent, were created, viz., (1) a new Governorship-in-Council of Bengal, re-uniting the five Bengali-speaking divisions, entitled the Presidency, Burdwan, Dacca, Rajshahi and Chittagong divisions, with an approximate total area of 70,000 square miles and a population of about 42 million; (2) a Lieutenant-Governorship-in-Council, to consist of Behar, Chota Nagpur, and Orissa, with a legislative council and a capital at Patna, the area of this Province being approximately 113,000 square miles, and the population about 35 million; and (3) the restoration of the Chief Commissionership of Assam, the area of which will be 56,000 square miles, with a population of about 5,000,000.

In order to appreciate the importance of these new administration divisions, it is desirable to call to mind that they supersede a very different state of things which has been in existence since 1905, when the reconstruction of the former Provinces of Bengal and Assam, popularly described as the "Partition of Bengal," was carried out. This again, it may be useful to recall, had consisted in the formation of a new Province, Eastern Bengal and Assam, the main object of that change being to reduce the area of Bengal, up to then 189,837 square miles, with a population of 78½ millions, to 141,580 square miles, with a population of 54 millions. Although the reduction in size of the former unwieldy Province had been rendered imperatively necessary, and though the relief afforded to the overworked administration of Bengal during the six years that the so-called "partition" has been in force, has proved considerable, the Government of India have frankly admitted that the partition aroused "violent hostility" amongst the Bengalis, and this is avowedly the mainspring of the movement which has resulted in the formation of the new Provinces. The Governor-in-Council of Bengal will, unlike his predecessors, have the advantage of a second capital at Dacca, with all the conveniences of ordinary provincial head-quarters, and thus be enabled to keep in close

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touch with Mohammedan sentiments and interests. With regard to the Lieutenant-Governorship-in-Council for Behar, Chota Nagpur, and Orissa, one of the chief considerations has been the desirableness of giving the Hindi-speaking people hitherto included in Bengal a separate administration. Regarding the cost of the new scheme, no attempt at an accurate estimate at the time of the Durbar was possible, because the Viceroy purposely avoided making inquiries, lest the proposals in contemplation should be prematurely disclosed. The confident hope, however, is entertained that the cost of the transfer of the capital cannot possibly exceed four millions sterling, a sum which would include the three years' interest on capital which would have to be paid till necessary works and buildings were completed. On the other hand, there would be valuable sets-off in the sale of Government land and buildings no longer required at Calcutta, and reduction in the current expenditure involved in the annual move to and from Simla, which is, of course, far nearer to Delhi than to Calcutta. The actual railway journey from Calcutta to Simla takes forty-two hours, while Delhi can be reached from Simla in fourteen hours.

FOURTH INTERNATIONAL ART CONGRESS, DRESDEN, 1912.

An International Congress for the Development of Drawing and Art Teaching and their Application to Industries will be held in Dresden from August 12th to 17th. It is concerned with all branches appertaining to the teaching of drawing, from the elementary school to the practice of fine and applied art in institutions devoted to the technical training of students.

The previous congress was held four years ago in London, and the magnitude of the exhibition, arranged in a portion of the Victoria and Albert Museum, showed the public generally, and art teachers in particular, that the subject promised to become more vital in the future, and its educational aims were more than hinted at.

At Dresden, some of the galleries erected for the International Hygiene Exhibition last year are to be devoted to another exhibition, where it is hoped that further progress will be demonstrated. In order to concentrate the general show upon particular points, it has been resolved to exhibit more definitely the work in secondary and trade schools, and in technical schools and schools of art.

The United States of America will send a large exhibit, demonstrating the entire art scheme as carried out in selected towns of different areas and having varied industries.

The Germans will show the organisation and results of their trade and technical schools, while Austria will do the same kind of thing, but upon a smaller scale.

The Board of Education, the Scotch Education Department, the Department of Agriculture and Technical Instruction for Ireland, are all contributing both exhibits and delegates, thus representing the British Government. The London County Council will be amply represented, while collections from provincial schools of art and from English secondary schools have been gathered together by the National Society of Art Masters and the Art Teachers' Guild. Welsh secondary art education is represented, owing to the strenuous efforts of an enthusiastic teacher in Swansea. Last, but by no means least, Mr. Ebenezer Cooke, the veteran teacher, who, in his enthusiasm and unselfishness has imbued a vital spirit in the teaching of drawing both here and abroad, has been specially invited to contribute work.

The papers to be read will also be more concentrated in character. The subject of "Lettering" will be treated by Mr. Edward Johnston, whose paper will be illustrated by a demonstration. Mr. J. T. Ewen, H.M.I., will speak of the progress made in Scotland, by which certain art schools are linked up with the universities, and the whole status of the art student put upon a broader and higher basis.

Delegates are being sent from many county councils and educational bodies, and it is hoped that friendly intercourse with colleagues coming from all parts of the world will help greatly to make all see that which makes for vitality, and for true education of the mind, through the hand and eye, as well as the points in the technical training of students.

A large party of teachers has been organised to start on the August Bank Holiday, in order to spend the journey profitably and pleasantly, by visiting Hanover, Hildesheim, and Brunswick, on the way, and thus, by seeing a little of Germany itself, to become more receptive of its aims and ideals.

HOME-GROWN WHEAT.

In a paper on "Home-Grown Wheat," recently read before the Farmers' Club, Mr. A. E. Humphries said the chief hope for wheat-growing in this country rested upon cheapening production, increasing the yield per acre, and improving the milling quality; there was no reason to expect great alterations in value in either direction. British and Irish farmers might well be proud of their existing yields, but the highest possible had not yet been reached. No one variety of wheat was suitable, nor were we likely to provide one suitable, for all the varying sets of natural conditions existing even in our small islands, and a detailed study of each set and the provision for it of a variety, or varieties, in the highest degree suitable to it, was likely to raise our already high yields. The diminution or eradication of susceptibility to certain plant diseases was also an important development in modern science likely to increase substantially the average yield per acre.

Another method of increasing the profit of wheat-growing was to improve the relative value of the product. The relatively low value of

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English wheat was due to two main causes. The one of lesser importance was the high percentage of water, which, however, was not a characteristic of the wheat of last year's growth. The great point was the inferior quality of British wheat. The inherent fault was that it was nondescript according to current standards of excellence; it had no outstanding merit for bread-making purposes. Mr. Humphries answered the question—Can we produce in the United Kingdom wheats possessing the necessary qualities on an average of years?—in the affirmative. On that point doubt no longer existed. But could such varieties be made to yield a sufficiently large financial return to the grower? —that was the problem which the Home-Grown Wheat Committee of the National Association of Millers set out to solve, and they were confident that the answer was in the affirmative.

He proceeded to describe the work of the committee and the Cambridge experiments in raising Mendelian wheats. From the results already achieved with Burgoyne's Fife he considered that the problem of raising a wheat combining milling quality and prolificacy was in a fair way to being solved.

THE CONSUMPTION OF FOOD IN PARIS, 1911.

The following statistics, lately published by the Prefecture of Police, which controls the markets of Paris, gives the quantities of some of the principal articles of food brought to the Halles Centrales last year as compared with those of the previous year:—

	1910.		1911.	
	Metric tons.	English tons.	Metric tons.	English tons.
Meat	56,797	55,902	54,763	53,900
Poultry and game	23,607	23,235	22,255	21,904
Fruit and vegetables	46,157	45,430	59,535	58,597
Butter	15,076	14,838	13,921	13,702
Cheese	14,605	14,375	12,828	12,626
Number of eggs	312,524,000		300,868,000	
Number of vehicles engaged in bringing produce to market	324,000		327,000	

Although a considerable falling-off is noticeable in the quantities of meat, butter, cheese and eggs brought to market last year as compared with those of 1910, the supply of vegetables was considerably larger. The amounts realised by the sales of produce in 1911 were also greater.

THE MUSEUM OF OCEANOGRAPHY AT MONACO.

The Museum of Oceanography, which owes its existence to the Prince of Monaco, Albert I., is certainly one of the most important institutions of the kind connected with this wide field of study and research. Founded in 1899 to contain the rich collections made by the Prince during his numerous scientific voyages in his yachts, the "Princess Alice" and the "Hirondelle," since 1885, the aims of the institution have been extended, and now include all that relates to oceanographic knowledge and the advancement of marine biological studies.

The museum at Monaco is built on the side of a cliff, overlooking the sea, at the east end of the beautiful gardens of St. Martin. The foundations of the building are carried down to the level of the sea, some 53 metres (174 ft.), below the main entrance situated in the Avenue St. Martin. The building is 100 metres (328 ft.) in length. The ground floor, besides a fine entrance and reception-room, contains a grand hall, suitable for conferences, lectures, etc., which occupies the entire west wing, whilst the east wing contains the collection of marine animals and plants arranged in their zoological or botanical order. The centre of this hall is occupied by the skeletons of a Greenland whale (*Balaena mysticetus*), 20 metres long (66 ft. 6 ins.), brought in one of the expeditions of the Prince from Spitzbergen, and a cachalot, or sperm whale (*Physeter macrocephalus*), 16 metres (52 ft. 6 ins.) long. There are also fine specimens of the seal, walrus, and other marine animals, including a manatee (a cetaceous herbivorous mammal) from the River Amazon. The collection of fish, molluscs, crustaceans, and echinoderms, is very complete. Amongst the crustaceans may be noticed a specimen of the *Macrocheira Kempferi*, an enormous spider-like creature from Japan. Four expeditions to the Polar Seas, as far as 80° N. lat. furnished specimens of the flora and fauna of those regions to compare with those of the Mediterranean and North Atlantic Ocean, and more especially with the animal and plant life of the Azores, Bay of Biscay, the coasts of Portugal and Morocco.

Many specimens were brought up from great depths, in some cases even from 6,000 metres (3,560 fathoms, about 3¾ miles) below the surface. Living specimens of the *Centrophorus* have been obtained in the Mediterranean at a depth of 2,700 metres (over 1,400 fathoms).

On the upper floor are shown nets and appliances of every description used for fishing, traps for catching animals and fish, many of which were designed by the Prince himself, or by his assistants. At the top of the staircase is the little whale boat belonging to the yacht; models of the two yachts named "Princess Alice," both of which were built by Messrs. Green, of Blackwall; and a model of the "Hirondelle," built at La

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Seyne, near Toulon. The collection of nets is very complete, and includes the ordinary deep-sea nets, Hensen's nets, vertical nets with large meshes, seine nets, and the fine nets used for collecting the "plankton"* from the surface of the water whilst the ship is in motion; trawl nets and apparatus for trawling and gear of every description used in trawling. In some cases trawling was carried on to a depth of 5,310 metres (3,218 fathoms). Harpoons, guns for throwing harpoons and other appliances for the capture of whales, are also shown.

The collection of instruments used by the Prince in his investigations is also very interesting and numerous. It includes a variety of floats and apparatus used for determining the direction and measuring the velocity of ocean currents at different depths; sounding machines of various systems, and apparatus for bathymetrical research of every description. Specimens of rock, sand, clay, pebbles, and even the casts of marine worms, which have been brought up from the bottom of the ocean in various places, are also shown. The bottles used for taking samples, and automatically registering the temperature of the water at different depths, apparatus for determining the chemical composition and density of the water, as well as the instrument used for ascertaining and studying the penetration of light to different depths, and other instruments, find a place in the museum.

The aquarium is situated on the lower of the two floors of the basement, and occupies the east wing of the building. The numerous tanks vary in size from 1 metre (3 ft. 3 ins.) to 6 metres (19 ft. 6 ins.) in length, are well stocked with a variety of fish of various kinds—crabs, lobsters, star fish, an octopus, and a quantity of sea anemones. A tank of larger dimensions contains several large conger eels. In one corner of the building is a large shallow tank, containing two sea tortoises, brought from the Azores in 1896, one of which has increased in weight from 3 kilogs. to 40 kilogs. ($6\frac{3}{4}$ lbs. to 88 lbs.) in the meanwhile. A small aquarium contains some lively specimens of the sea-horse, a curious little creature, somewhat resembling the Knight in a set of chessmen.

The water to supply the aquarium is raised from the sea by two pumps, driven by electricity, to a height of 64 metres (210 ft.), into a tank placed near the top of the building. It is aërated before entering the aquarium by an ingenious arrangement on the principle of the injector used for steam boilers.

The west wing of this floor contains a well-equipped naturalist's workshop, with all appliances and tools suitable for mounting large specimens.

On the upper floor of this basement are the biological laboratories, workrooms, photographic studios, with dark rooms, etc., and other laboratories for research of various kinds. Here, too, are the library, offices, and store-rooms.

The museum also contains an interesting series of charts by which the relative distribution of the principal forms of life in the ocean is graphically displayed; for instance, the proportion of land to water on the globe, etc.

The chemical composition of sea-water in different parts of the globe is also illustrated graphically, whilst the different proportions of sea salt contained in the water of the Baltic, Red Sea, Mediterranean, and Atlantic Ocean, is brought prominently to mind by a series of glass jars containing salt, as compared with a cube measuring one metre.

* "Plankton," name given to the heterogeneous collection of minute and microscopic animals and plants found floating in the upper layers of the sea.

CORRESPONDENCE.

THE MANUFACTURE OF NITRATES FROM THE ATMOSPHERE.

I have read Mr. Ernest Kilburn Scott's interesting paper in the *Journal of the Royal Society of Arts* of May 17th.

On page 654 the contracts for machinery, etc., of the Rjukanfos installation are given. It is a most significant fact that not a single contract was given to a British firm.

Can British firms not compete, or can they not manufacture the up-to-date plant required? Or is it the frequent case—"no Britishers need apply"?

R. HOWARD KRAUSE.

OBITUARY.

SIR JULIUS CHARLES WERNHER, BART.—Sir Julius Wernher died at his residence, Bath House, Piccadilly, on the 21st inst. Born at Darmstadt in 1850, he was educated at Frankfort-on-the-Main. In 1870 he came to London as a clerk in an Anglo-German firm, but on the outbreak of the Franco-German War he returned to his native country and served as a trooper in a dragoon regiment, being present at the fall of Paris. After the close of the war he went out to South Africa with Mr. Jules Porges, and remained for nearly ten years at Kimberley. In 1880 he returned to London as the English partner of the firm of Porges and Wernher; but four years later he went back for a time to Kimberley, and it was then that he formed his connection with Mr. Alfred Beit. In 1888 Rhodes and Beit brought about the amalgamation of the diamond mines at Kimberley, as a result of which Wernher became a life governor of the De Beers Corporation. In addition to this, he was a director of the Rand Mines, and chairman of the Central Mining and Investment Corporation.

Mr. Wernher was created a baronet in 1905. He took a deep interest in education, and served on Lord Haldane's Committee on the Royal College of

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Science and Royal School of Mines, whose report led to the establishment by Royal Charter of the Imperial College of Science and Technology. Last year he was awarded the gold medal of the Institution of Mining and Metallurgy in recognition of his "great personal services to the advancement of technological education." A short time before he had given £10,000 to the National Physical Laboratory for the extension of its metallurgical department; and he presented a sum of about a quarter of a million pounds sterling to assist in endowing the new teaching university for the whole of South Africa, which it is hoped will be established at Cape Town.

Sir Julius Wernher became a member of the Royal Society of Arts in 1899.

NOTES ON BOOKS.

Lectures on Cellulose. By C. F. Cross, F.I.C. London: The Institute of Chemistry of Great Britain and Ireland. Price to persons not connected with the Institute, 2*s.* 6*d.*

The lectures form the second course delivered under the scheme recently instituted by the Council of the Institute of Chemistry, under which Fellows with special knowledge and experience in certain branches of work give lectures for the benefit of young chemists and advanced students who are qualifying themselves for industrial appointments. The first course, "Lectures on Cement," by Mr. Bertram Blount, was noticed in these columns last month.

As Mr. Cross points out in introducing his subject, the word cellulose, from the industrial point of view, covers an enormous field, including cotton, hemp, linen, jute, ropes, twine, straw, and timber, and representing an annual gross figure of not less than two hundred million pounds sterling; and if we add coal, which is "certainly derived in the main from cellulose by processes of regulated destruction," we must increase this gigantic total by another hundred and fifty millions. It is obviously impossible to deal with all these industries in so short a space, and accordingly, in his first lecture, Mr. Cross discusses a few prominent examples of industrial problems as illustrations of principles, and in the second he takes certain types of carbohydrate colloids, such as starch, hemi-celluloses from seed-endosperms, and cellulose hydrates, concluding with some interesting and suggestive remarks on the enormous waste which at present goes on in certain cellulose products, such as cornstalks, rice-straw, megasse, sawdust, etc.

Textile Design. Pure and Applied. By Thomas Woodhouse and Thomas Milne. London: Macmillan & Co., Ltd. 10*s.*

A cursory perusal of this well-produced, solid volume, containing more than 500 pages, illustrated with over 300 carefully worked-out diagrams, is calculated to enhance the very general impress[illegible] of the bewildering technicalities of the weaver's art. To the general reader, or indeed to any student not conversant with the mechanisms an[illegible] methods made use of in modern weaving, a car[illegible] study of the work would be very wearisome and would but slightly elucidate the mystery, for the reason that the authors have, in so many cases, omitted to explain the meaning of the technical terms made use of, which are often of quite local signification, and the relation of certain procedures described to the machines on which they are to be carried out.

In their preface the authors mention that the present volume is Part III. of a formerly published serial work which dealt with the whole subject of jute and linen weaving. It is probable, therefore, that many of the points which are obscure in the book before us would be elucidated by reference to the former parts. But explanatory notes and a glossary of technical terms would have readily obviated the difficulty. No technical work, indeed, can be considered complete or satisfactory without such aids to the reader's understanding.

The students to whom this work on textile design will mostly appeal, and should prove to be of the greatest use, are those employed in the design department of textile manufactories of all kinds. For, as the writers truly say on page three of the introductory chapter: "Apart altogether from the requirements which are demanded of a designer in any particular branch of textile industry, it is, in his own and his employer's interest, very desirable that he should study widely the different types of cloth structure. Ideas spring from many sources, and no opportunity should be neglected of becoming conversant with the vari[illegible]us sides of one's occupation."

The most interesting and important portion of the book, about one-fifth of the whole, is that whi[illegible] deals with cloth structure, or the actual in[illegible]lacement of warp and weft in all their variatio[illegible] This is very thoroughly explained and illustra[illegible] by means of a great number of clear and we[illegible] designed diagrams. In many cases the effect [illegible] the various twills, satins, and other ties, or interlacements, is shown by half-tone blocks made from photographs of actual cloth, in addition to the drafts on ruled paper.

Chapters v. to viii., and chapter x., are devoted to a description of the forms and peculiarities of small patterns, which can be woven without the u[illegible] of the Jacquard machine. These go by the name of *Spiders*, *Herring-Bones*, *Diamonds*, *Diape[illegible]* *Dices*, and *Spots*. Full directions for working [illegible] the designs for these, and entering the w[illegible] threads in the harness of the loom in the pr[illegible] order to weave them, are given, as well as p[illegible] graphs of their finished effect in the woven cloth[illegible]

Damask weaving, which forms the subje[illegible] matter of chapter ix., is somewhat inadequate[illegible] described, although it is, perhaps, the most inte[illegible] esting and perfect of all pattern-weaving. Th[illegible] general principles on which it is based are bare[illegible]

alluded to, whilst many unimportant details in the working out of particular designs are given in full. From an artistic point of view, too, the examples [illegible]design given for damask weaving leave much to be desired, although it may certainly be conceded that they are types of ornamentation which are in common use.

The chapters xi. to xv., on compound fabrics—that is, fabrics in which two or more warps or wefts are used—are clearly written and well illustrated. It is duly and correctly noted that warp effects are more economical in production, and therefore more suitable for weaving by power, than effects of weft. It is therefore only to be expected that warp effects are more used in modern weaving, whilst weft effects, which require more personal attention by the weaver, characterised ancient textiles.

Two chapters are next devoted to an explanation of double and treble cloth-weaving, both plain and figured. Some of the diagrams illustrating these compound fabrics are extremely well constructed and clearly drawn. Particularly instructive are such diagrams as that on page 328, with its analysis on the previous page.

In the last portion of the work, chapters xviii. to xxv., the technique of both cut and uncut pile machine weaving is treated of, as well as machine carpet-weaving and the imitation of elaborate brocades, which are at the present time so much in demand.

Apart from its usefulness to the textile designer, the whole work is interesting to the student of historic weaving, showing, as it does most clearly, that little that is new and original in the construction of cloth, either plain or ornamental, has been devised in modern times. Most of the fabrics figured in this volume are only counterparts of [t]hose made by the hand-loom weavers of Renais[sa]nce or mediæval Europe, or even of ancient [P]ersia, India, and China.

[P]RACTICAL LESSONS IN BOOK-KEEPING. By Thomas Chalice Jackson, B.A., LL.B. Sixth Impression. (Fourth Edition.) London: W. B. Clive. 3*s*. 6*d*.

Book-keeping is a science that continually progresses, the student of to-day being expected to have some knowledge of its application to such subjects as partnership law, income tax, joint-stock company accounts; and great progress has been made since 1899, the year in which the first edition [o]f this work appeared. Of course, the more [e]lementary portion, dealing with the theory of [bo]ok-keeping, remains more or less as it was; but [th]e latter part of the text-book (pp. 145–367), [tre]ating of the applications of modern methods generally, is entirely new.

Mr. Jackson states in his preface that in the metropolitan area alone approximately 25,000 students—usually from fifteen to twenty-one years of age, and mainly engaged in commercial pursuits—enrol themselves in evening classes for tuition in book-keeping. This text-book, which is written on very practical lines, is designed to meet the needs of such candidates, and the fact that it has now reached its sixth impression is sound evidence of its popularity.

THE APPLICATION OF HYPERBOLIC FUNCTIONS TO ELECTRICAL ENGINEERING PROBLEMS. By Professor A. E. Kennelly, M.A., D.Sc. London: University of London Press. 6*s*. net.

Professor Kennelly's book has the most useful merit of lucidity. It covers the same ground as a series of lectures given by the author last year for the University of London at the Institution of Electrical Engineers. As he states in his preface, he has two central ideas. The first is that the theories of continuous currents and alternating currents are essentially the same, and continuous current formulæ for potential, current, resistance, and power, may be applied to alternating-current circuits by the substitution of complex numbers for real numbers. In one of the appendices he deals with a case where this does not appear to apply. In an electro-magnetic receiving instrument employed on a long alternating-current circuit, the formula for the force is not obtained from the corresponding continuous current formula; for the force in this case is essentially "real." The second idea referred to is that there is a proper analogy between circular and hyperbolic trigonometry, giving the notion of the "hyperbolic angle," which is of so great importance in much of the theory of electric engineering. A series of appendices give explanations of some of the points which require further elucidation, and add to the value of the book. The reader who is previously unacquainted with hyperbolic functions, will find there, amongst other things, enough information to enable him to follow the use of these functions throughout the book.

In more than one place Professor Kennelly indicates directions in which further investigations might very profitably be made. We cannot help thinking that this is a book which will stimulate research.

GENERAL NOTES.

THE OLIVE-OIL PRODUCTION OF SOUTHERN ITALY.—The manufacture of olive oil is one of the most important industries of southern Italy, and particularly in the region known as Apulia, of which Bari is the port of export. Fifty years ago the greater part of the yield consisted of common oil: now nearly the whole can be used for edible purposes, and the quality obtained is not inferior to other well-known Italian oils that have successfully been introduced into foreign markets. The area under olives in Apulia is estimated at about 520,000 acres, with an average production of about 60,000 tons of oil. The quantities of olive oil exported to the principal countries in 1910 were as

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follows, in tons. France, 1,691; Great Britain, 810; Austria-Hungary, 615; United States, 493; Germany, 215; Portugal, 155; Egypt, 155; and Argentina, 100. An extensive branch of the olive-oil industry is the manufacture of sulphur oil (soap stock), which is produced by special treatment with carbon bisulphide of the "sansa," or olive refuse, remaining in the crusher after repeated extractions of oil. Several large soap-stock factories are in operation, and the quantity exported from Bari during 1910 amounted to 6,025 tons, of which 2,668 tons were shipped to the United States.

SERVIAN FRUIT CULTURE.—The principal fruit cultivated in Servia is the plum, and the total area under cultivation in 1910 was 380,000 acres. Only a small portion of the plum crop is exported in fresh condition. The largest portion is transformed into dried plums (prunes), or into a species of marmalade without the addition of sugar, known in Servia as "pekmez." The inferior plums are utilised for making brandy. The plum-drying industry is extensive and remunerative, the Servian prunes, owing to their fine aroma, being in demand throughout Europe. The average annual quantity of prunes exported from Servia during the past ten years was 32,665 tons. Other fruits extensively cultivated are apples and pears. Apples are exported in considerable quantities. The average annual apple yield for the past ten years was 38,000 tons.

THE TUNNY FISHERIES OF SICILY.—The tunny fisheries of Sicily, some forty in number, are located along the northern coast of the island from Trapani to Messina. The fish are caught in May and June, and the quantity canned annually varies from 15,000 to 40,000 boxes of 80 kilogrammes (kilogramme = 2·2 pounds) each. The tins used hold from one-fourth of a kilogramme to twenty kilogrammes. From the refuse of the canneries about 10,000 kilogrammes of tunny oil are extracted, the average price for the oil being about £2 per 100 kilogrammes. This is shipped to Genoa, whence it is sold to firms in northern Italy, or exported to foreign countries for use in the manufacture of chemical products. To extract the oil, the refuse is boiled from twenty-four to forty-eight hours, and then passed through metal presses similar to those used in olive-oil establishments. The presses are of Italian make. The pressed-fish residue is called "bagamo," and the entire output, which is estimated at 400 tons annually, is used in Sicily as a fertiliser.

A PROPOSED NEW INDUSTRY IN MALAYSIA.—It has been proposed to start a small export trade in Malaysia in shark's-liver oil. This oil is refined in Europe, and sold as cod-liver oil. In October, the ocean sharks come into the lagoons, between the barrier reef and the atolls, to pair. At this time they can be speared in large numbers by people skilled in catching them. There are several species of these sharks, and they ordinarily run from seven to fifteen feet in length. The girth of an ordinary shark is the same as its length, and an eleven-foot shark would be eleven feet round the body. The liver of a shark of this size gives about five gallons of oil. The oil brings £15 a ton. The sharks are found in pairs, and the harpooners try to kill the male first, in which case they are able also to spear the female, as it does not desert its mate.

CULTURE OF SEA-ISLAND COTTON IN CUBA.—A company at Artemisa, Pinar del Rio Province, Cuba, has for the past three years been carrying on a series of experiments in the culture of sea-island cotton. The chief desire was to demonstrate whether or not cotton grown in Cuba under certain conditions of culture, and planted during the autumn months, would be troubled with the boll weevil. The first crop was planted in September, three years ago, the acreage being very small, and selected sea-island seed from Florida was used. No boll weevil appeared, and a good crop of cotton was obtained. After the crop was gathered every particle of rubbish from the plant was burned. The second year produced equally good results, and the third year has proved that cotton planted in Cuba in September will escape the ravages of the boll weevil, provided that care is taken that the insect is not imported into the field, and that all rubbish is burned directly after the crop is gathered. This matter is of great importance to Cuba, as there are many localities in the island where conditions generally are favourable to the extensive growing of cotton of the long staple variety.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, MAY 28...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. M. Flinders Petrie, "The Formation of the Alphabet." (Lecture I.)

Quekett Microscopical Club, 20, Hanover-square, W., 8 p.m.

THURSDAY, MAY 30 ... Royal Institution, Albemarle-street, W., 3 p.m. Professor C. G. Barkla, "X Rays and Matter." (Lecture I.)

FRIDAY, MAY 31...Royal Institution, Albemarle-street, W., 9 p.m. Professor H. T. Barnes, "Icebergs and their Location in Navigation."

Engineers and Shipbuilders, North-East Coast Institution of, Newcastle-on-Tyne, 7.30 p.m. Discussion on "The Relative Possibilities of the Diesel Oil Engine, Geared Turbine and Suction Gas Engine, as compared with the Reciprocating Engine for Marine Propulsion."

Junior Institution of Engineers, 39, Victoria-street, S.W., 8 p.m. Mr. Arthur Bourne, "Standardization of Engineering Catalogues."

Physical, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Professor G. W. O. Howe, "The Calibration of Wave Meters for Radio-Telegraphy." 2. Dr. W. H. Eccles, "On the Use of Heaviside's Resistance Operators in Air-Core Transformer Theory." 3. Mr. C. R. Darling, "The Movements of Semi-oily Liquids on a Water Surface." 4. Mr. G. L. Addenbrooke, "Experiments on Surface Leakage in Alternating Electric Fields."

SATURDAY, JUNE 1...Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. L. Moore, "The Development of Meteorological Science." (Lecture I.)

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Journal of the Royal Society of Arts.

No. 3,106. VOL. LX.

FRIDAY, MAY 31, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, May 16th, 1912; THE RIGHT HON. SIR EDGAR SPEYER, Bart., in the chair.

THE CHAIRMAN, in opening the meeting, said that he knew nothing of Indian railways; he had never been to India, and he had never come into contact with Indian finance. When his friend the reader of the paper asked him to take the chair, and he (Sir Edgar) pleaded ignorance, Mr. Priestley would not let him off. He had, therefore, come to the meeting for the purpose of listening and learning. The author's qualifications to speak on the subject with which he was about to deal were of the highest. He had spent thirty-three years in the Railway Department of India, for many years of that time occupying the position of Traffic Manager to the Southern Maratta Railway. In 1901 he was appointed Under-Secretary of the Railway Department to the Government of India; in 1903 he was sent to the United States to report on the railways there; in 1905 he was made Secretary of the newly-constituted Railway Board; in 1906 he was appointed General Manager of the South Indian Railway; and in 1910 he was appointed Managing Director of the South Indian Railway in London. He, therefore, possessed the highest possible qualifications for dealing with the subject on which he was about to speak.

The paper read was—

INDIAN RAILWAYS.

By NEVILLE PRIESTLEY,
Managing Director, South Indian Railway.

The subject of my paper, Indian Railways, covers such a very wide field that it would be impossible to deal completely with it in one afternoon, without at the same time exhausting your patience and greatly exceeding the time allowed me.

There is its moral side: the influence which a railway exercises on caste and religion, as a consequence of the greater freedom of movement and the intermixing of people from the various parts of the country; its influence on Indian social customs generally; its influence on the Government itself in its civil, military, and political departments.

Then there is its material or economic side: its influence on the development of cultivation and land values; its influence on trade; its influence on the rates of commodities and wages; its influence as a means of protection against famine; its influence on the general prosperity of the country, as a consequence of the increased facilities for the movement of people and products from places where they exist in plenty to places where there is deficiency.

Then there is the practical side: the character, location and standard to which railways should be constructed; and the means to be adopted for the provision of capital for their construction; and for their improvement, after being opened for traffic, to meet their increasing business.

The moral and material influences cannot operate until the railway is provided; and before railways can be built it is necessary that capital should be provided to build them with.

It seemed to me, therefore, that my paper might be more useful at this present juncture, when the funds for railway purposes grow less ever vear, if I should try to deal, as exhaustively as the time at my disposal will allow, with the practical side of my subject, and especially with that portion of it which relates to railway finance.

I propose, therefore, to give you, in as few words as I can, a history of the policy which has been followed by the Government of India in regard to the financing of railways since their inception, and to try to lay before you the difficulties which seem to stand in the way of a more rapid progress than is being made in the construction of railways in India.

The first reference to the subject of railways in India was made in 1845, when the Honourable

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East India Company forwarded to the Governor-General applications from several gentlemen, who offered to promote companies for the construction of railways in India. They all asked for a guarantee of interest to be allowed on the capital, and the Court of Directors remarked that "that mode of co-operation was liable to many objections, and likely to prove very unsatisfactory," and that "railroads in India should be constructed and managed by means of private enterprise and capital." It was found, however, that no company would undertake the work without a guarantee of interest, and as the Court of Directors seemed doubtful of the feasibility of constructing and maintaining railways in the tropics, they were not disposed to enter upon an extensive scheme of railway construction, and consented to the construction of three experimental lines only, of a total length of 192 miles, namely, a line from Howrah to Raneegunge (120 miles), a line from Bombay to Kalyan (33 miles), and a line from Madras to Arkonam (39 miles).

Later, the Court of Directors began to realise that without the material appliances which facilitate and cheapen the means of communication and production there could be no rapid progress in the country, either morally or materially; and they expressed the wish that India might, without unnecessary loss of time, be given the immense advantage of a regular system of railway communication.

The question was reviewed by Lord Dalhousie in an exhaustive Minute written in 1853. He urged the importance of a speedy and wide introduction of railway communication throughout India; he pointed out the great social, political and commercial advantages of constructing railways to connect the chief cities; and he specially recommended that, in the first instance, a system of trunk lines should be formed, connecting the interior of each Presidency with its principal port, and connecting the several Presidencies with each other.

The Court of Directors accepted the general plan proposed, and by the end of 1859 eight companies had been formed for the construction of nearly 5,000 miles of railway, with a capital under guarantee of 52½ millions sterling. Those companies were the East Indian, the Great Indian Peninsula, the late Madras, the Bombay, Baroda and Central India, the Eastern Bengal, the Oudh and Rohilkund, the Sind, Punjab and Delhi (now merged in the North-Western State), and the Great Southern of India (now the South Indian, and since converted to the metre gauge) Railways, all constructed on the 5 ft. 6 in., or what is now generally known as the broad gauge. They were given a free grant of all land required for the railway and a Government guarantee of 5 per cent., Government reserving to themselves the option of acquiring the railway at the end of twenty-five years, or at intervals thereafter.

In agreeing to give a guarantee, Government anticipated that no call would be made upon them for it; but all expectations in regard to profits were destroyed by the heavy outlay on the railways, due chiefly to their being constructed to a standard far in excess of the needs of the time or the actual work which the railways were designed to perform. Conveniences were provided which, while in themselves desirable, were unnecessary for the safe or efficient operation of the railway, and some of the lines were built with a double track, the necessity for which did not arise till a generation later. The earnings which might, and doubtless would have been sufficient to cover interest charges on a reasonable expenditure, proved utterly inadequate to meet the guaranteed interest on the outlay actually incurred, and Government had to make good the deficit, which in the year 1868 had reached the large sum of 166½ lacs, or £1,496,918. A general rise in prices and wages which took place about this time, coupled with the Orissa famine of 1865–67, followed by the prolonged drought in the United Provinces and Rajputana in 1868–70, made the increasing demands on account of guaranteed interest extremely inconvenient, and the whole guarantee system fell into disrepute.

When, therefore, it was desired still further to extend the railway system, the guarantee principle was regarded as too burdensome to the country, and, as unguaranteed private enterprise still held aloof from railway projects, it was decided in 1869 that the State should build all railways in the future, and provide the capital from loans or from the surplus revenues of the country. It was at the same time decided to adopt the metre, or 3 ft. 3⅜ in., gauge for railways to be constructed by the State, as the 5 ft. 6 in. gauge, to which the railways had till then been constructed, was found to be too costly.

As a result of this change in policy, the Indus Valley and the Punjab Northern Railways (since converted to the 5 ft. 6 in. gauge and now merged in the North-Western State Railways) and the Rajputana-Malwa (now merged in the Bombay, Baroda and Central India) Railway were constructed, and later the Tirhoot (now merged in

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the Bengal and North-Western Railway), the Northern Bengal (now merged in the Eastern Bengal State Railway), and several other lines of less importance which have been absorbed by the railways adjoining them.

Government, however, soon found that, in consequence of war and famine, they could not maintain the provision of funds requisite for uninterrupted construction, and they were again obliged, in 1876, to resort to guaranteed companies. The improved condition of the money market and of the country generally, enabled Government to get the capital on much easier terms, and the Bengal-Nagpur, the Assam-Bengal, the Indian Midland (now merged in the Great Indian Peninsula), and the Southern Mahratta Railways were constructed under the revised terms.

About the same time, endeavours were again made to induce unguaranteed companies to undertake construction, and four companies responded, namely, the Nilgiri, the Delhi-Umballa-Kalka, the Bengal Central, and the Bengal and North-Western. The first of these became bankrupt; the second and third eventually received a guarantee; and the Tirhoot State Railway had to be leased to the fourth to enable it to earn a sufficient dividend to satisfy its shareholders.

When the country recovered from the effects of war and famine, construction by the State was again resumed; but the amount of money which could be made available for railway purposes was small, and Government had soon to face the further difficulty arising out of a steadily falling exchange. The fall in exchange at last became so serious that Government felt obliged to curtail their gold liabilities, which necessarily increased so long as they continued constructing railways from funds provided or guaranteed by the State; and they again sought the assistance of the public. They could not offer a guarantee, but they did offer what seemed to be the next best thing, namely, money help until the company had secured its position as a dividend-earning concern.

In pursuance of this policy, rules, known as the Rebate Terms, for the construction of railways without a guarantee, were formulated and published in 1893. These rules allowed of the grant of free land; of the branch being fully equipped with rolling-stock by the main line and worked by it for not more than 50 per cent. of the branch's gross earnings; and of the payment by the main line of a rebate up to 10 per cent. of the gross earnings derived by the main line from traffic interchanged with the branch, so as to make up the dividend to 4 per cent.

The Southern Punjab, the Ahmedabad-Parantij and the South Behar Railways, 506 miles in all, were constructed under these rules, but the terms notified had to be considerably modified to secure the promotion of the companies—the South Behar Railway had eventually to be guaranteed—and it was made clear that the terms were not sufficiently attractive to the investing public.

The embarrassment caused by the shrinking rupee was put an end to in 1893 by the stoppage of the free coinage of silver, which arrested the fall in exchange. But Government did not yet feel able to launch out freely on railway expenditure. The net earnings of railways did not anything like cover liabilities in connection with railways, and while this deficit continued Government hesitated to enter upon such a programme of railway construction as the needs of the country demanded, because of the fear that any increase in gold liabilities might lead to further taxation to make good the deficit in the railway account.

By 1896 this deficit had reached nearly 259 lakhs of rupees, or over $1\frac{3}{4}$ millions sterling. An endeavour was, therefore, again made in 1896 to attract private unguaranteed capital, but as the 1893 branch line terms had produced such very small results, the total additions to the mileage of railways constructed under these terms having been only 506 miles, the rules for the construction of branch lines were revised with a view to making the terms more attractive. The new rules permitted of the grant of free land; of the branch being fully equipped with rolling-stock by the main line and worked by it for a sum which was not to exceed 50 per cent. of the branch's gross earnings; and of payment by the main line of a rebate up to the full extent of the net earnings derived by it from traffic interchanged with the branch, so as to make up a dividend of $3\frac{1}{2}$ *per cent. in rupees* on the capital as entered *in rupees*.

While, therefore, the new rules widened the benefits in one direction, they took them away in another, and it was soon made quite evident that the revised terms were even less attractive to the public than the 1893 terms. Only three railways, the Tapti Valley, the Ahmedabad-Dholka, and the Mymensingh-Jaggannathganj Railway—a total length of 245 miles—were promoted after the issue of these revised terms, but in no case were the actual terms prescribed

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adhered to, and in the case of the first two lines the 1893 terms were preferred.

The Government were, therefore, once more driven back on their own resources. These, however, were now in a better condition, as the anxiety on account of the annual deficit in the railway account was passing away. In 1900 the corner was turned, and in that year, for the first time in the history of railways in India, there ceased to be a deficit. The net earnings derived from railways not only covered all liabilities, but left a surplus balance of no less a sum than Rs. 8,72,391, increased in the following year to Rs. 115,41,198. It was now believed that there would no longer be any difficulty about providing all the funds required for railway purposes in India, and, on strong representations from Lord Curzon's Government, an enlargement was made of what is known as the "Programme," and money was more freely provided by the State for capital expenditure on railways.

But a difficulty which had so far been rather brushed aside in the anxiety to provide funds for new lines of railway, now began to force itself on the attention of Government. Throughout the period of financial stringency, the major part of the money which could be made available for railways was devoted to the construction of new lines. The construction of these new lines, which were all internal lines, threw an increasing amount of business on to the old or seaboard lines, which were already finding it difficult to conduct their own very rapidly-developing business. It soon became apparent, therefore, that unless the existing railways were to fail in their purpose, funds, and large quantities of funds, must be supplied to them to enable them to provide the necessary facilities in the shape of rolling-stock, larger stations, etc., and in some instances even the doubling of lines, for the carriage of the traffic offering.

The Government seemed unwilling to raise more money to meet these increasing demands, so the only way out of the difficulty was to curtail the programme of construction of new lines and to make larger allotments of funds to existing lines. This was accordingly done, but it satisfied neither claimant for funds. The situation eventually became so acute that a Committee was appointed by the Secretary of State in 1908, under the presidency of Sir James Mackay (now Lord Inchcape) to report, among other matters, on "whether the amounts allotted in recent years for railway construction and equipment in India are sufficient for the needs of the country and for the development of its trade, and if not then what additional amounts may properly and advantageously be raised for this purpose."

The Committee reported "that the equipment of Indian railways had been unequal to the requirements of trade"; and they recommended "that the allotments for railway construction and equipment should be increased beyond those of recent years." They further expressed the opinion "that for some years to come the effective limit of the amount to be spent in any year will be the amount that can be provided," and they recommended "that the programme of annual expenditure on railway construction and development in India be for the present fixed at £12,500,000, equal to £100,000,000 in the next eight years."

In no single year since these recommendations were made has the Secretary of State found it possible to provide so large a sum of money as £12,500,000 for railways. In 1911–12 all that could be provided was £9,500,000, of which no less a sum than £6,358,000 had to be devoted to existing lines. Of the balance, new lines already begun were given £2,382,000, and the very small amount of £760,000 was allotted for the construction of further new lines. The position, apparently due to political reasons this time, is still worse for the year 1912–13. The total allotment is only £9,000,000, of which £6,341,200 is allotted to existing lines. Of the balance, £2,578,800 is to be spent on new lines the construction of which had already been begun, and the very insignificant amount of £80,000 is to be devoted to the construction of new lines, with which sum *fourteen miles of line* are to be constructed. It is, however, expected that a further sum of £203,100 will be spent on new lines, of which £43,333 is to be contributed by the Famine Insurance Fund, £3,466 by provincial governments, and £156,266 by branch lines companies. But even with this addition, the total amount to be spent during the year on new lines is only £283,100, which means that during the year about seventy or eighty miles of new railways will be begun, when 1,000 miles a year would not be too generous a programme of railway construction for India. In other words, the work of opening up the country by the construction of new lines is practically at a stand-still.

That the country needs every penny of the 12½ millions sterling which Sir James Mackay's Committee considered that it should be given, is very clearly demonstrated by the reports of

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congestion on railways which come home from India by every mail, and the clamorous demands for more new lines from all parts of the country. That the Secretary of State has real difficulty in providing so large a sum from the resources at his disposal is also very clearly demonstrated by the reception given to the recent 3½ per cent. India loan of £3,000,000. The issue price was fixed as low as 93 per cent., and yet only 15 per cent. of the loan was subscribed by the public. The Secretary of State had secured the issue by having it underwritten; but it must have cost another 1 or 1½ per cent. to get this done, and the amount actually received could not have been more than 92 or 91½ per cent.

With evidence such as this before him, it is perhaps not surprising that the Secretary of State hesitates to go to the market for large sums of money; but the demand for funds for railways must be none the less met, if the progress of the country is not to be arrested; and a further attempt is being made to try to induce private unguaranteed companies to undertake the construction of new railways, by again revising (in June, 1910) the branch line terms.

It will thus be seen that the railway financial policy of the Government of India has been one constant see-saw; that their best intentions have been frustrated at one time by famine, at another time by war, at another time again by currency difficulties, at another time by political considerations, and at all times by the state of the money market; and that at the end of sixty years the position is that only 33,100 miles of railway have been constructed altogether in a country whose area is 1,773,168 square miles, whose population is over 300 millions, and the development of whose trade, indeed of the country itself, is being hampered, and badly hampered, by the want of adequate facilities. Of these 33,100 miles of railway, the State has itself had to build about 26,000 miles, either directly or through companies under its guarantee; only 1,573 miles have been constructed by companies without a Government guarantee, and only 1,139 miles by companies under the Rebate Terms. In other words, the conditions governing the provision of funds without a State guarantee have not had the effect of attracting the investing public, and Government have been obliged to find practically all the money required for railway purposes in India.

Of the remaining mileage, 3,882 miles of railway have been provided by Native States, notably Hyderabad, Mysore, Baroda, Jodhpore, Bikaner, and the Kathiawar and Punjab States; and 354 miles by or under the guarantee of District Boards, of which 199 miles were constructed in Bengal and 155 miles in the Madras Presidency.

Several of the district boards in the Madras Presidency, chiefly on the initiative and advice of Mr. (now Sir Francis) Spring, have, with very commendable enterprise, commenced to raise a fund for the construction of railways in their districts by levying a special cess of three pies in the rupee on occupied lands. Up to the end of March 1911 they had between them collected Rs. 43,30,605, or £288,707; but no railway has as yet been begun, as no one of these District Boards has so far collected enough money from its cess for the construction of the railway in which it is interested, and there have been difficulties of one kind and another in the way of its raising a loan or obtaining the money by guarantee on the security of its cess. How soon, therefore, these railways will be begun it is difficult to forecast. There seems a tendency for the Government and District Boards to require railways of high standards, and if that policy is adopted it must be many years before enough funds will have accumulated to cover the cost of the several railways.

Whether the branch line terms of 1910 will be found sufficiently attractive to investors remains to be proved. They are undoubtedly conceived in a more practical and generous spirit than were the terms of 1893 and 1896. Speaking broadly, they allow, with other concessions of less importance, of the branch being provided by Government with free land; and of its being equipped with rolling-stock by the main line and worked by it for not more than 50 per cent. of the branch's gross earnings. So far, they are the same as the rules of 1893 and 1896. The new rules, however, allow a rebate by the main line of such a sum not exceeding in any year the net earnings of the main line from traffic interchanged with the branch, as shall, together with the branch's own net earnings, make up an amount equal to interest at the rate of 5 per cent. per annum on the capital expenditure of the branch. But they specially require that the capital must be expressed in rupees, and that subscriptions must be invited only in India, and they are made applicable only to "branch lines forming feeders."

The experience of the past has not shown that capital is forthcoming in any large

quantity in India. Even Government loans do not attract more than a small portion of the money required for the service of India. The sum so far raised under the new branch line terms for expenditure in the year 1912–13, after the terms have been before the public for twenty-one months, appears to have been only £156,266, with which sum sixty or seventy miles of railway can be constructed. It is, therefore, more than doubtful whether a sufficiently large amount can be raised in India every year under these terms to increase appreciably the rate of construction and to afford any real relief to Government; and if the rule is rigidly adhered to of requiring the capital to be raised only in India, the prospects of accelerating railway construction are not bright.

Then if the terms are confined to "branch lines forming feeders," the Government will still have to find the money for lines which do not strictly fall within this category. There are numbers of such lines still to be provided all over India, especially in Central and Southern India, and if the Government are to rely upon their own resources to find the capital for these lines, the experience of the past few years does not hold out much hope of their construction in the near future.

But in any case the success of the new terms will depend upon whether there is a reasonable prospect, amounting almost to a certainty, that the income of the branch from its own earnings and from the rebate will yield a return of 5 per cent. on the company's capital from the date of opening and a higher return within a very few years after opening. That a lower return will not attract capital—in England, at all events—is very evident from the fact that good, safe investments, like the Bengal and North-Western and Southern Punjab ordinary unguaranteed stocks are quoted in London at prices which yield over 5 per cent. to the investor. That returns of 5 per cent. and more can be obtained from the day of opening, by branch lines constructed in India, has been demonstrated more than once; but whether they will be obtained depends upon three factors—namely, the outlay on the branch, the earnings of the branch and the value of the rebate.

The expression "Rebate" has not been very happily chosen, and is not understood by, or easily intelligible to, the ordinary investor. What Government really offer is a subsidy; and though they refrain from fixing a definite amount to that subsidy, and leave the amount to automatic adjustment, it is still a concession which may have a considerable value and may make just the difference between failure and success. Their offer is that if the branch line's income from its own local traffic, that is traffic which does not pass off the branch, and from its own share of the income from traffic interchanged, that is, traffic which is exchanged with the main line, is not sufficient to pay 5 per cent. on the branch's capital, then the main line shall pay to the branch such share, up to the whole of the main line's net income from the traffic exchanged with the branch, as may be required to make up the branch's income to 5 per cent. Government do not pledge themselves that the addition of this rebate will make the dividend up to 5 per cent., and the investor has to take the risk that it may not do so.

Unfortunately Government do not give any idea of what income may be expected by the branch from the main line on account of rebate. There have been numerous branches opened all over India, and the value to the main line of the traffic interchanged with these branches could have been easily ascertained, and would have proved very valuable in enabling people to estimate the amount they might expect to derive from rebate and their chances of a 5 per cent. return on their money.

The Railway Administration reports, however, show that in the case of the Southern Punjab Railway, which at the time was 400 miles long, and which received the same amount of rebate as is offered under the new terms, namely, the entire net earnings of the main line from interchanged traffic, the rebate received from the main line varied between 0·11 and 0·60 per cent. on a capital outlay of Rs. 53,651 per mile. In the case of the Tapti Valley Railway the rebate received from the main line is shown to have been between 0·25 and 0·35 per cent. on a capital outlay of Rs. 83,190 per mile; but the rebate in this case was payable only to the extent of 10 per cent. of the gross earnings, and not to the extent of the entire net earnings of the main line from interchanged traffic.

The income per cent. on the branch line's capital that will be obtained from rebate, depends, in the first place, on the amount of the rebate itself, and in the second place on the amount of the capital outlay; and the amount received as rebate will yield a high or low percentage on the capital, according as that capital has been low or high.

Assuming that the outlay on the branch is kept sufficiently low to allow of the rebate yielding a full 1 per cent. on the branch's

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capital, then the branch must earn 4 per cent. from its own earnings to yield a return of 5 per cent. to the investor.

Taking all the railways which have been constructed at various times in India, not one quarter of them have earned more than Rs. 80 a mile a week during the first few years of their existence; and there are some railways yielding large returns on their capital which, after having been opened for several years, are not yet earning Rs. 80 a mile a week.

To obtain a return of 4 per cent. out of a gross income of Rs. 80 a mile a week, and a net income of Rs. 40 a mile a week, the working expenses being taken at 50 per cent. of the gross earnings, the outlay, *including preliminary expenses and interest on capital during the period of construction*, must be kept within Rs. 52,000 a mile.

It is not impossible to construct a serviceable railway in India for this amount. Many have in times past been constructed for much less. But if the cost is to be kept within the limits which the income justifies, the ideas as to the standard to which railways should be constructed, at present so widely held in India, will need to be considerably modified and the Government rules governing the construction of railways in India will need to be revised.

Those rules require bridges to be built strong enough to carry on the 5 ft. 6 in. gauge an axle-load of 22½ tons, and on the metre gauge an axle-load of 12½ tons. Girders strong enough to carry these weights may be necessary to-day in the case of the great trunk lines of Northern India; but in the case of many railways in India they will not be necessary during the life of the girders; and in many others they will never be necessary at all at any time. In the case of the South Indian Railway, after the 5 ft. 6 in. gauge section has been open for over fifty years and the metre gauge section for over thirty-five years, the heaviest axle-load is only 16 tons on the 5 ft. 6 in. gauge, and 9 tons on the metre gauge, and we have been advised that it would not be easy to design an engine for the metre gauge with a 12½ ton axle-load. Nevertheless, all new bridges on our system, and all bridges on projected lines off our system are required to be designed strong enough to carry the weights prescribed. Then the rules require all platforms to be built 600 ft. long and 18 ft. wide, even though it may not be intended to book any passengers to or from the station, as at stations which are opened only for the purpose of crossing trains. The length of sidings or loop lines at stations is prescribed as 1,800 ft., when half that length would in most cases be sufficient, at the beginning at all events. Banks and cuttings have to be of a standard inconsistent with economical construction, ballast of a full section is required, and a weight of rail is demanded sufficiently heavy to permit of the highest speeds from the date of opening.

These rules are not the product of to-day or yesterday. They are the growth of years, and, beginning at a period antecedent to the formation of the Railway Board, they have from time to time been revised in the direction of greater stiffening, until they are to-day as stated above.

Though the actual rules were issued subsequent to the construction of the Tapti Valley Railway, the result of the policy which they enforce may be seen in the Tapti Valley Railway. It cost Rs. 83,190 a mile for its 155 miles, when the country could have been opened up for a considerably lower outlay. In the first year after it was opened to traffic its gross earnings were Rs. 74 a mile a week; its net earnings and the rebate together represented 2·90 per cent. on the capital outlay; and it was five years before it began to earn more than 4 per cent. on its capital. The consequence was that the shareholders were bitterly disappointed; the branch line terms were seriously discredited; and when the promoters of the Tapti Valley Railway tried later to promote the Ahmedabad-Dholka line, they were unable to get the public to subscribe all the capital required; and, to save the project from failure, Government had to lower the standard of construction and had themselves to take up the shares which the public had refused to subscribe.

The question of revising the bridge rules and the book of standard dimensions is now under the consideration of the Railway Board; and it remains to be seen whether they will be so revised as to permit of the construction of railways to such a standard and at such a cost as will afford a reasonable prospect of the income which it is estimated the line will earn, yielding, with the assistance of the rebate, the return of 5 per cent. of which hopes are held out by the branch line terms.

In every case where the capital cost of a line has been kept low, as in the case of the Ahmedabad-Dholka and the Ahmedabad-Parantij metre-gauge lines and the Amritsar Patti 5 ft. 6 in. gauge line, the railway has, from the commencement, fulfilled and handsomely fulfilled, the expectations of investors. Where consideration

has not been given to the amount of capital outlay, as in the case of the Tapti Valley Railway, the project from the point of view of the original investor was a complete failure. Even the Southern Punjab Railway, splendid property as it is to-day, and cheaply as it was built, was constructed too expensively for the anticipated income, with the result that for several years after the line was opened the shareholders did not receive an adequate return on, and were greatly dissatisfied with, their investment.

The branch line terms have, presumably, been notified with the serious desire to attract unguaranteed capital, not in small amounts but in such large amounts as will relieve Government of the necessity of finding funds for new lines; and if they are not to fail in their purpose, it must obviously be the particular care of Government to see that the outlay on any line projected under the terms is kept within such limits as will afford a reasonable prospect of the earnings yielding the return of which the terms hold out hopes. No one is more interested than Government are that the terms should prove successful; and if, for reasons of policy, uniformity of gauge is necessary, or a higher standard is required in the case of any particular line than the income expected from the line would justify when the project is considered from the investors' point of view, then an unguaranteed company should not be allowed to undertake the line and it should be constructed by the State.

It is, however, a question for serious consideration whether even the State itself is justified in spending the large sums which high standards necessitate when the country could be sufficiently well served by less expensive lines; and in imposing charges on the general revenues of the country in consequence of the failure of the railway to earn sufficient to cover interest charges on its high outlay, at a time when the programme of new construction is being seriously restricted and the country needs all the money it can get for educational and other purposes.

The country in many parts is devoid even of metalled roads, and what it wants is means of easy communication, not high-grade railways over which trains can be run at express speeds; and a business man, whose property needed opening up and developing as badly as India does, would strive for quantity and leave quality to follow later, when business had developed sufficiently to justify quality as well.

That, at any rate, is the view which the Jodhpore and Bikaner Durbars have taken of the matter. They have built light, cheap, metre-gauge lines, which have cost them, fully equipped with rolling-stock, only Rs. 25,606 a mile for the 831 miles of which their system consists; and these lines have served their territories perfectly efficiently for the past thirty years.

Compare this with the Nagda-Muttra Railway, which has just been constructed by the State, and has cost Rs. 118,000 a mile for its 339 miles, not reckoning interest on capital during construction, which amounted to about another Rs. 12,000 a mile. Local circumstances may make it impossible always to construct as cheaply as the Jodhpore and Bikaner States have constructed their railways; but there is a very wide margin between Rs. 25,606 and Rs. 118,000. The country traversed by the Nagda-Muttra Railway could have been sufficiently well served in the first instance by a light broad-gauge line for half, and by a light metre-gauge line for much less than half of the sum actually spent on the Nagda-Muttra line and two miles or more of railway might have been given to the country for every one that has been provided; and this, notwithstanding the fact that Government have been so badly pressed for funds that they are reduced in the present year to a construction programme of *only fourteen miles* from funds provided by themselves, and to another sixty or seventy miles from funds provided by outside agencies.

There are thousands of square miles of country in India whose progress, both material and moral, is being retarded for want of railway communications. Every district now short of railways can support a railway of some kind; but few of them can straightaway support a railway built up to modern ideas of standard.

Is it, then, wise statesmanship, in the circumstances, to pour money into lines of the standard of the Nagda-Muttra—it is not the only one of its kind under construction at the present moment—and open up only a few miles of territory each year? Or is it truer statesmanship to emulate the policy of the Jodhpore and Bikaner Durbars and open up numerous miles of territory each year with light cheap lines? Those are the really important questions for Government to consider, and on the decision which is arrived at will depend the success or failure of the new branch line terms.

If no regard is paid to the amount of the capital outlay on new lines, and if companies are not only permitted but compelled to construct to a standard entirely out of harmony

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with the income expected, the new terms cannot prove any more successful than the old. But if the capital outlay is made to come down to such a figure as will ensure a reasonable prospect of the anticipated income yielding 5 per cent. at once with the assistance of the rebate, and more than 5 per cent. within a very few years after opening without the assistance of the rebate, my belief is that the new branch line terms will achieve the object which their framers had in view, provided, of course, that they are modified in the directions already indicated, and in a few other directions of not great importance from the point of view of Government; and that they will be the means of procuring, without a State guarantee, all the capital required for the construction of new lines in India, and of procuring it in ungrudging amounts. If other countries, and even South American republics, can get all the money which they want for railways without a State guarantee, there is no reason why India, with her credit as high as it is, should not be able to get all the money she wants also, if she too will treat a business proposition in a businesslike way.

DISCUSSION.

The Chairman (Sir Edgar Speyer), in opening the discussion, said he was sure he was expressing the wishes of the meeting in offering to the author their heartiest thanks and congratulations on the most able and interesting paper he had read. As he had stated in opening the meeting, he was entirely ignorant on the subject of Indian railways, and he hoped any remarks he ventured to make after listening to the paper would be taken as the expression of a business man not conversant with Indian problems, but one who looked upon the question broadly, because all business had certain underlying principles, whether it was carried on in India, Canada, or any other country in the world. The fact that had struck him most in the able survey the author had given was that the railway provision in India must be insufficient. The statement had been made in the paper that there were 33,000 miles of railways in India, a country with an area of 1,773,000 square miles, and a population of 300 millions. Figures were only significant by way of comparison, and there were two other sets of figures which came to his mind to which he would like to direct attention. Canada had about the same number of miles of railway as India, 32,000, or would have in a year, when some of the trans-continental lines were finished; and Great Britain had about 30,000 miles of railways, so that the three countries of India, Canada and Great Britain had about the same length of railway lines. But India had a population of 300 millions, Canada eight millions, and Great Britain 45 millions, and the author had therefore made out a good case, even to those who knew nothing about India, that that country was not sufficiently provided with railways. It seemed to him a most extraordinary thing that the educated and wealthy population of India should not be sufficiently interested in providing more railways than existed to-day, and that they should not appreciate the civilising mission and the fructifying factors which all the railways in the world had been shown to possess. No doubt there were good reasons for such a state of affairs, but the problem seemed to him to be one not only for India, but for the Empire at large. The people of this country wanted India to be developed, in order that she might produce foodstuffs and other things which the world required very badly. As he listened to the author he could not say that he felt like blaming the Indian Government for the lack of railway communication which existed; he rather felt sympathy with them, because the history the author had unfolded clearly showed that the Government were in a very difficult position. So far as finance was concerned, a subject on which hs was supposed to know a little, it seemed to him that the Indian Government had been very much handicapped. Those present no doubt appreciated that, before the Trustee Act came into operation, Indian Government Stock shared with Consols the great privilege and distinction of being practically alone available for the investment of trust money. On the passing of the Trustee Act that was changed, and the Indian Government was now placed in competition with all the Colonies. He did not think that was a bad thing; on the contrary, no doubt it was a right thing to do; but the old happy days in that respect were over for India, and when it required money they knew that other people wanted money too, and that the credit of Indian stocks could not be the same as it used to be. That action must have had its effect on railway construction, because whilst formerly trust funds were available only for Indian stocks and Consols, at the present moment a great deal of trust money did not go to India. The Indian Government, therefore, had to be very careful in its policy about railway construction and other expenditure. Another point about Indian credit generally was the fact that all over the world at the present time the public wanted a better return for its money, as a consequence of which very high-class investments were not so much sought after at the present moment as they were ten years ago. That was partly due to higher expenses of living, which was again due to greater gold production in a large measure, and also to the extravagance of most people who required a better return for their money. All those points affected the question. Another point to be borne in mind was that, anywhere in the world where railways depended on Governments, development was slow. He did not say that for the sake of making the criticism that Governments were slower than individuals. They were bound to be. After all, in every Government, if it were examined,

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it would be found there was also some red tape sticking out of some coat pocket. He did not wish it to be understood that he was an opponent of State railways. That was by no means the case. He thought that question entirely depended on the country; it was impossible to generalise. On the whole, he believed the future would be with Government railways. He thought they would more and more drift into State railways all over the world; but he thought the author had made out a case that in India the State railways had not sufficiently developed the country—at any rate not fast enough. The great question, it seemed to him, which the paper asked was, why had private capital not been attracted to India? No doubt it was partly due to political reasons. Capital was timid, and the stories of unrest in India had no doubt frightened capital to a great extent. It was to be hoped that after the King's visit, which had been such a great success, that unrest would be on the wane, and from all he heard there was great hope that that would be the case. If that was so, he hoped capital would be more attracted towards railway construction in India. But what he could not understand, and what he hoped subsequent speakers who knew India would explain, was how it was that Indian native money, of which a great deal existed, was not forthcoming. There must be some reason for that state of affairs. He could not judge whether, if a different policy had been pursued by the Government, better results would have been obtained, and the case called for careful inquiry. He confessed that, after listening to the rules which the author had explained, he would not personally attempt to build railways in India. Life was too short to work under such complicated rules, but possibly many clever people were satisfied with them. His experience had never led him to the East, but he knew that in Canada the Government had a very practical way of encouraging railway construction. He had been interested in one railway there himself. The Government generally in those great railways guaranteed a first mortgage of a limited extent, and showed its faith in the future of the line. Private enterprise then came along and took a second charge, and that system had proved eminently successful in Canada. He did not know whether it would be applicable to India, but he threw it out as a means by which money had been raised in other Colonies. One point which the author made seemed to him to be eminently sound, namely, that railways in their initial stages were built too substantially. Heavy charges on a young enterprise due to that fact seemed to him to be unsound. In the United States of America, where railway construction had proceeded in a very remarkable way in the last fifty years, the railways were generally built by private enterprise. The rule, generally, had been to build railways lightly, to trust to the development of the country, and to use the surplus for strengthening the railways afterwards. Had that not been done, he was sure the railway mileage of the United States would not be what it was at the present time, and he thought the author had made out a strong case from the point of view that Indian railway policy was open to question. A great desideratum, as the author had emphasised, was how to attract money to India, and it should not be beyond the wit of man—certainly not beyond the wit of business men—to solve that question. After all, conditions changed, and it was sometimes necessary to have a change in policy. He wondered whether something like the following policy would attract capital, namely, that one of the successful lines in India should be taken over by a private company, at a fair valuation, and be run as a private concern. That, he thought, would have several advantages. First of all, he was a believer in private enterprise, because he believed, without wishing to give any offence, it was more elastic and more efficient than a Government could ever hope to be. If people put their money into a concern, they did their very best to get a good return for their money, but Governments were not exactly in the same position. If the results of such a railway being taken over by a private company were very good, and the surpluses were used to build branches, and good dividends were earned, that would perhaps encourage capital to come along and build railways which were so sadly needed in India. It might be the means of stimulating railway construction in India, and be a great encouragement to investors. That might be a counsel of perfection. Everyone present appreciated the great importance of the subject, and, after having listened to the paper, he confessed he felt tempted to give the matter more attention than he had done in the past.

Sir Bradford Leslie, K.C.I.E. (Chairman, Southern Punjab Railway), said the Government terms for branch lines were framed with the view of inducing zemindars, district road boards, and others locally interested to form Indian companies to undertake their construction. The rebate system was defective because, firstly, however cheaply constructed, for several years after opening the local receipts of a branch line might be absorbed by working expenses; and, secondly, initial rebate on the traffic of an undeveloped district might be insufficient to supplement any net receipts to the extent required to make up the total receipts to 5 per cent. The first difficulty was generally got over by the parent line undertaking to provide rolling-stock, and work and maintain the branch at 50 per cent. of its gross receipts. That gave the parent line the right to dictate the standard to which the branch was to be constructed. The parent line took care to protect itself by requiring the highest standard it could, viz., the State railway standard, with the result that on that basis the estimated cost was often prohibitive. It would be better policy to permit construction to be of the cheapest type, by which through communication could be effected sufficiently for initial traffic. Alignment, curves, grading, ballast, permanent-way, bridges, stations,

etc., could all be gradually improved. Capital for improvements reasonably necessary, as traffic increased, should be debited to the branch line, excepting minor works which were usually charged against revenue. In many cases it would be an advantage to permit second-hand material, removed from the parent line, to be used for the construction of branches. That would enable the trunk lines to realise a good price for material no longer fit for main line traffic, and thereby lighten the cost of renewals. He trembled in making such a suggestion for fear of incurring the censure of the orthodox. The second difficulty, namely, that in undeveloped districts local earnings plus rebate might be insufficient to amount to 5 per cent., even on a cheaply constructed line, could only be surmounted by the trunk-line system or State agency, either of which could afford to make extensions into unsettled districts, trusting to future developments. In cases where the great trunk-line systems made, maintained, and worked their own branches in their own territory, they should be absolutely unfettered by grandmotherly legislation as to standards of construction. The only danger was that branch-line construction might be used to relieve the cost of main-line working—a possibility that could hardly be imagined in these days of expert managing directors. Indian railway companies were administered and managed by accomplished staffs, second to none in the world. Assuredly Government might trust those men to make branch lines that would answer the purpose, namely, to afford railway communication to outlying districts, with due regard to efficiency for initial traffic. Surveys and estimates must, of course, be subject to Government approval, but men with local experience were the best judges of the scale on which the railway should be constructed. To enable new lines to earn 5 per cent., not only must capital outlay be kept down, but traffic had to be carried at very low rates to compete with ekkas, bullock carts, camels and donkeys. Government inspections to see that the sanctioned standard was complied with were necessary and were always welcomed by railway officers, but it should be left to the local administration, on the recommendation of their departmental officers, to fix the type that would afford communication in the cheapest way they could, with the resources at their command. Unless that principle was accepted, railway extension, of all things the most important for the welfare of India, could never progress as it should. The cost of construction was 30 per cent. higher than it was twenty years ago; and prices were still rising. The longer railway construction was deferred the more it would cost and the less it would pay.

Mr. L. R. W. Forrest said he was sure those who had listened to the paper hoped the author would on future occasions treat of the other sides of the Indian railway question, and describe the influences the railways were having on the social, religious, political and economic conditions of India. The author had very properly commenced with the finance, without which there would be no railways to discuss, and had given a clear description of how the capital was raised, and for which lines it was raised from the very commencement. He had referred to the recommendations of the Committee of 1908 for the raising of £12,500,000 a year, which had not been found possible. With all due deference to the India Office, he (the speaker) thought it would be possible if the authorities would be more liberal in their terms. With Canada, Brazil, Russia, and other countries offering 4 to 4½ per cent. for railway debentures and guaranteed bonds, it was simply delaying the development of India to refuse to allow the various main lines to issue debentures except at impossible rates, in the present condition of the demand for English capital from all parts of the world. The Indian railways could afford to pay 4 per cent., and if that rate was offered as much capital as was wanted could be raised, probably at a slight premium. One quarter per cent. made all the difference in attracting investors, and that meant some £7,500 a year for interest on three millions, a trifling figure compared to the benefit gained by that extra expenditure. He asked those present to consider the loss caused to the railways, to the cultivators, to merchants and mine-owners during the present year by the want of waggons and the want of a second line of rails on some of the lines. He alluded especially to the G.I.P. Railway, which was refusing traffic from three of the adjoining main lines, partly for want of rolling-stock and partly from having only a single line of rails between Nagpur and Bhusawal. The shortage of waggons on the East Indian Railway had caused the consumer to pay for his coal an excess in price which would cover the extra interest many times over. The author had given an interesting account of the hitherto half-hearted attempts of the Government to attract rupee capital, and had properly commended the last endeavour made in the form of concessions, by which a rebate was given towards a return of 5 per cent., with division of profits over 5 per cent. Those terms appealed to the native public. They liked the slightly speculative character of that not quite gilt-edged security, and a kind of capital was attracted which would never go into 3½ per cent. rupee paper. Owing to good trade and high prices for produce the wealth of India had increased enormously since 1905. Having been connected with feeder lines since the commencement, and his own firm having already raised three crores, he could speak with a certain amount of authority, and he could distinctly say that any amount of capital would be available on those terms if the schemes were forthcoming. But would they be? The general concession was good enough, but disputes on petty details, whether the rebate was payable on the capital issued or on the cost of construction, the amount of remuneration for office expenses and of management before division of profits, and the delay in sanctioning

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projects, all deferred the formation of companies. But the chief obstacle was the unwillingness of the main lines to assist. With perhaps a single exception, there was now no attempt on the part of their managers, or even of State line managers, to develop those feeders through other companies. No suggestions were even made or invited. One reason was, no doubt, that as those main lines had, in the interests of India, been remodelled on a 4 per cent. basis, they naturally objected to assisting another company to earn a possible 5 per cent. He was strongly of opinion that Government should give any rebate necessary out of their three-quarters to fifteen-sixteenths share in the earnings of the main line, and not ask the London company to join. It was the Government of India that benefited politically by those extensions with rupee capital, and in their revenue by the increased value of land. Such an arrangement would make it much easier for promoters of feeder lines to come to terms, and projects would be more amicably arranged between the Railway Board and the other two parties. He trusted that suggestions from one absolutely *au fait* with the question of feeder lines would receive attention from the authorities. The members of the Railway Board were decidedly anxious to promote the extension of those rupee railways. He thought the Government should not tie themselves down so rigidly to certain declarations. Different proposals required different treatment. There were many lines which might be made, especially some in the neglected Province of Eastern Bengal, if there was more elasticity in Government's rules for concessions. He did not think there was a very large scope for feeders on the present expensive scale, but there was a huge field open for light railways, such as Mr. Priestley had recommended, and which was so admirably commenced by Mr. Home in the Jodhpore Railway. With reference to the author's remarks about the Tapti Valley, he was glad to say that it was now earning 5 per cent. It was the only one of the first four new feeder lines that had ever taken any rebate, and the following figures showing the increase of passengers and traffic might be interesting. The Tapti Valley Railway carried 420,936 passengers in 1901 compared with 1,184,621 in 1911, while the goods traffic increased in the same period from 104,073 tons to 228,675 tons. The Parantij Railway carried 332,385 passengers in 1903 and 772,776 in 1911, the goods traffic increasing in the same period from 52,540 tons to 92,400 tons; while the Dholka Railway passenger traffic increased from 282,038 in 1904 to 527,489 in 1911. Those figures showed that, although the traffic on a line when it was first constructed did not give much encouragement, after a few years the traffic receipts would probably be very much greater than were anticipated.

Sir J. D. Rees, K.C.I.E., M.P., pointed out that the author, in the excellent paper he had written for the purpose of informing the British public of some of the main facts relating to Indian railways, had not mentioned one way in which branch lines might be made and railway construction improved in India, namely, by getting the India Office to place the matter as far as possible in the hands of the gentleman who had given the underground railways to London. It was through the interest of gentlemen like the Chairman that the question would march forward, because it would never progress by simply following along straight official lines. It was necessary to get the subject brought as far as possible into the City of London. The great railway men of London should be tempted to interest themselves in the matter, and then possibly the intrinsic merits of Indian railways would have a far better chance of being acknowledged than if they continued to be worked on the lines hitherto adopted. There were enormous advantages in India with regard to railways which were not possessed in this country. In the first place, there was no Parliament, and there was none of that ill-informed persecution which pursued railway enterprise and was killing it in this country. Every project for extension or for improving railway communications was met in England with the most unintelligent opposition. If British capital was to go into India there must be less talk about Colonial self-government for India, because he did not think British capital would be in a hurry to seek an investment in India unless the Government was maintained on something like its present lines as a British-controlled Government. One of the reasons why rupee capital had not been coming forward was that the people who possessed it had no confidence in the people who talked in India, and who appeared to have more influence with the authorities than those solid men who would be in a position to invest capital in railways and other enterprises of that sort. An effort had been made by another school of thought to represent railways as competing with irrigation. That was an absolutely absurd contention. Irrigation schemes could only be carried on with justice to the general taxpayer when they offered a fair return, whereas a railway after a short time paid by itself, and he believed he was right in saying there was about half a million surplus at present on the railway account in India. So that the problems of irrigation and railways were not in opposition, but they should work together, and the more railways were made the far better chance there was of more irrigation schemes being carried out. The Chairman had referred to the question of the private management of railways. The Government of India showed a very practical belief in the superiority of private management by placing in the hands of private companies for management railways which practically belonged to the State; and if any further proof were needed that that was a wise system, it was only necessary to bear in mind the state of affairs which existed on the Western Railway in France, which, under State management, was conspicuous for bad management, accidents, bad returns, and generally for the evil contrast it

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afforded with the lines which were under private management. He desired to emphasise Mr. Priestley's point as to the absolute necessity of keeping the cost of the construction of railways down. He thought everyone who knew Indian railways, with the expensive cut-stone stations scattered about all over the country, considered them an absurd waste of money. A shanty very similar to what was called a "halt" on the lines in this country would do perfectly well. Even on the line with which the author was connected, he must have blushed over and over again to see the palaces which were reared up for stations alongside the mud huts on the sun-baked fields. The only purpose they served was to increase the cost of construction, and he hoped that matter would receive the attention of the authorities. He was not surprised at the fact that capital was not forthcoming for the construction of railways in India in any large quantity. If once it got into the mind of the people in England who supplied capital that there was going to be some fundamental change in the Government of India, some federal system giving great control to local bodies, and that they were not to be completely controlled financially by British officers, he did not think that influx of capital would be forthcoming which was required in order to provide India with anything like a sufficiency of railways. It was all very well to say that other countries could get the money without a State guarantee, but anybody who knew anything about the South American Republics, for instance, knew that directly they had any labour difficulties they immediately introduced martial law and put an end to them. That might not be a practicable system in this country, but it was very comforting to investors. There seemed to be a wave of feeling right through the British Empire that complete changes were to be introduced in the direction of more democratic management. All he could say in answer was that people with money had no confidence in democratic management. They believed in the management of financial concerns by solid people who understood financial business. He hoped it was reserved to the author to interest British capital in Indian railways, and the fact that Sir Edgar Speyer was in the chair seemed to him to be a very happy augury.

Sir Arundel T. Arundel, K.C.S.I., thought there were only two ways in which it was possible to escape from the dilemma in which they found themselves with regard to the difficult question of capital for railway construction in India. The Secretary of State said he could not find the capital that was necessary at the interest which he was prepared to offer. In the first place there was the question of the raising of capital in rupees in India. It was well known that certain small railways had been successfully built, and were paying more than 5 per cent., which had been financed in that way. But the construction of these railways depended to a large extent upon the action of the district boards, which required education and guidance by the district officers. It was necessary to pierce the barrier of the embargo set up by the Government rules that railways must be built of a very high grade from the beginning. He hoped that when the question of Indian railways was raised in the House of Commons, Sir John Rees would urge the necessity of reducing the standard upon which the Government of India insisted at the outset. The same principle might possibly be adopted in the initial construction of railways in India as had been adopted in the United States and in Canada.

Sir James Wilson, K.C.S.I., said he was not a railway expert, nor a financial expert, nor a director of a railway, but he was very much interested in the welfare of the people of India, and he desired to look at the question from their point of view. The author had naturally confined himself to the financial aspect of the question, but the very great indirect advantages that would accrue to the people of India and others concerned from the construction of railways must also not be forgotten. When a railway was constructed in a country where previously there was no good communication it tended to raise the value of the produce and to steady prices. It gave more employment to the people, and above all it saved them from the risks of famine. There would have been a much larger mortality in India during the recent droughts had it not been for the railways. The construction of railways was also a very great advantage to traders. It gave them more trade, not only in the locality itself, but on the seaboards through which the produce passed. It was an advantage even to this country, because it obtained a large amount of produce from India. All those indirect advantages should be taken into account, and even if the Government of India could not show that they had a financial profit on railway construction, it would still be advisable to extend the railways at a small financial loss. But was there any financial loss? It had been stated that the capital outlay on lines opened in India up to the end of 1910 was 293 millions, the net earnings on which were sixteen millions, which gave a return on the capital expenditure of 5½ per cent. The figures for this year were still more satisfactory. He found that the total debt of India a year ago was 275 millions, of which almost the whole had been spent upon railway and canal construction, upon what were called productive public works, which were expected to do more than pay the interest on their capital expenditure. In 1910–11 the net gain to the State from railways alone was put down at £2,866,000, after paying, not only the cost of management and working expenses, but the interest on the capital cost of the railways, and that sum of money went to reduce the burden of taxation. The author had shown that the Government of India had been struggling for a generation to get private investors to put their money into Indian railways without giving them

a direct guarantee. In the early days of railway construction the Government guaranteed 5 per cent., and any amount of money was available on those terms. It was only since the guarantee had been stopped that private investors had been chary of investing their money in Indian railways. If the money could not be obtained in any other way, he thought it would be to the advantage of the people of India to offer a guarantee of 4 per cent. at the present time, and plenty of money would then be forthcoming for the development of Indian railways. But why should the Government give a guarantee at all? There were any number of schemes in India of railway construction which, if carried out by the Government on the principles recommended by the author, would be certain in a few years to pay 5 per cent. profit after paying their working expenses, and why should not the Indian taxpayer have the benefit of such a good investment? If he could borrow at 3¾ per cent. and invest his money at 5 per cent., the more money he could borrow and invest on those terms the better for the people of India, and the more the net profit would be which went to reduce the burden of taxation. He thought the difficulty that had been mentioned in connection with the raising of money for investment in India had been very much exaggerated. At all events, the Government of India could borrow money on most excellent terms compared with other countries. No doubt it had to pay more interest now than it did fifteen or twenty years ago, but just as Consols had gone down so had Indian Government securities. The Secretary of State for India recently raised £3,000,000 in London at 93 on 3½ per cent. Indian stock, which meant he would have to pay £3¾ interest on every £100 he actually received. The Government could also borrow money in the Calcutta market in rupees at 3¾ per cent. If a man bought Consols at the present time at 78 he obtained about 3¼ per cent. on his capital expenditure, compared with the 3¾ which the Indian Government had to pay. The City of London had to pay 3½ per cent., Liverpool, 3½ per cent., France, 3½ per cent., Germany, 3¾ per cent., Canada, 3⅝ per cent., Victoria, 3⅝ per cent., Japan, 4⅝ per cent., Argentina, 4½ per cent., China, 5 per cent., Chili, 5 per cent., Italy, 4 per cent., Hungary, 4⅜ per cent., and Russia, 4⅜ per cent. Why should India, therefore, not be content to borrow 20 millions at 3¾ per cent., invest it in railways at 5 per cent., and make a very large net income for the Indian people? Personally he would be inclined to go much further than the author, and to suggest that the Secretary of State should declare that whatever be the state of the Indian finances, whether there be a surplus or deficit, a famine or a frontier war, so long as he could borrow money at less than 4 per cent., and could invest it in Indian railways which within ten years were likely to pay 5 per cent. on the capital charges, he would borrow in the next five years £20,000,000 a year, and spend it on Indian railways.

Mr. Priestley, in reply, said that he had no remarks to make, as practically every speaker seemed to agree with the propositions he had put forward.

Sir William Lee-Warner, G.C.S.I., in proposing a vote of thanks to the reader of the paper, and in acknowledging the obligations of the meeting to the Right Honourable the Chairman, observed that the chorus of approval with which the paper and the speech of Sir Edgar had been met rendered further remarks almost superfluous. He cordially agreed that the paper was a most valuable addition to the excellent series of the closing session, and he felt confident that he should strike no note of discord if he referred to a few considerations which had escaped notice. In so far as Mr. Priestley had argued that the expenditure devoted to railways might have gone further if restrictions had been withdrawn, and a more economical outlay on stations and construction permitted, he had no objection to raise. The suggestions deserved the careful consideration of the authorities, and were sure to receive it. Technical matters were, however, beyond the speaker's capacity, and he would not criticise details. But when the lecturer complained of a see-saw policy and of undue timidity in extending railways, and when Mr. Forrest and Sir James Wilson caught up the cry and advocated an extensive and almost reckless provision of funds, it was necessary to dwell on the solid reasons for a slow and well-considered advance. Some of these reasons affected the financial situation, to which the Chairman had referred when he mentioned the influence of extended trustee securities on the price of Indian Government securities. Other considerations suggested themselves to the speaker. Railways were not the only form of enterprise for which loans were needed. Irrigation schemes, port extensions, municipal works, and other undertakings, involved applications to the market and added to India's indebtedness. Then as regards the provision of funds from the year's revenues, the claims of education, sanitation, and other spending departments must be considered. Government could not afford a lavish expenditure or increased borrowing for one purpose, however good in itself, which might throw India's finances into difficulties or unduly increase the annual charges for interest which Indian exports must pay. Another set of reasons for caution affected railways in particular, and rendered the reference to Argentina, Canada, and other countries misleading. In the first place, Indian droughts paralysed railway traffic as no other visitations of Providence did in the countries named. Secondly, floods on the great rivers of India, especially on the Tapti and Nerbudda, to which reference had been made, constantly broke down bridges, flooded whole districts, and involved risks and expenses of an unusual kind. Thirdly, the trade of India was uneven and irregular. One year a crop of wheat and seeds that no railway

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could carry away before it got mildewed or otherwise spoilt by the rain, and another year no surplus of that product to be spared for export. This abnormal fitfulness of Indian trade was naturally objectionable to investors and traders, and it was a serious difficulty and cause of loss to railways. Again, population shifted. The new canal colonies were a striking example of deserts changed into populous districts, while in some parts the Indus, in its shifting course, swept away cities. Finally, there were political causes that affected India's borrowing powers as well as its income and expenditure. Sir John Rees had mentioned one, and, if the speaker might mention another, he would select the danger of a policy of protection. For any paltering with free trade which contracted the foreign market for Indian raw produce would ruin India's trade, decrease her railway takings, and injure her ability to pay interest on the capital already borrowed by her. All these considerations pointed to cautious, well considered advance in railway extension. A plunging policy would give India railways which she could never maintain. The Chairman had done a service to the Society in presiding, and his interest in art as well as his experience in business made his presence most appropriate. They all hoped to see him in the chair again, and Mr. Priestley had gratified but not satisfied the audience's appetite. They sincerely hoped that he, too, would follow up the large subject so well introduced by him, at a later date.

Sir M. M. Bhownaggree, K.C.I.E., seconded the motion, which was carried unanimously, and the meeting terminated.

Mr. J. Forrest Brunton writes: Of the paper itself, interesting and instructive as it is, I have little criticism to offer. It is largely historical, and where it is not so I agree generally with the author's conclusions, except that I am not so optimistic as he appears to be as to the success of the third and last rebate terms offered by the Government of India. While, however, there is little to criticise in the paper itself, there is much to criticise in the conduct of the Indian Government in regard to the so-called "encouragement of private enterprise" for railway extension in India—presuming, of course, that the Government of India really wished to encourage private enterprise, and this is to my mind a large presumption. I can conceive nothing more puerile than the rebate terms offered in 1893, 1896, and I fear than those of 1910 also. When the Government of India published the first rebate terms in 1893, I had the temerity to criticise them and to prophesy that they would fail to attain the object aimed at. In a letter published in the *Engineer* of December 29th, 1893, after pointing out, in the case of a particular railway then much advocated, and for which estimates of cost of construction and probable traffic had been prepared, that the additional encouragement of the 10 per cent. rebate amounted to one-fifth per cent. per annum on the estimated capital cost, I remarked: "Do the Government of India really imagine that this is adequate encouragement for the investment of private capital in India? If so they have a most extraordinary idea of encouragement, and I am afraid that capitalists will hardly appreciate their generosity." In a letter published in the *Journal* of this Society on June 28th, 1895, in which I offered some remarks on Mr. Parry's paper, "The Coming Railways of India," I again referred to these rebate terms and condemned them as valueless. I pointed out that they were radically wrong in principle. A sliding guarantee or subsidy of this kind, to be of any practical use, should increase in value in direct ratio to the need of the guaranteed. This rebate does exactly the reverse of this. If the branch line were carrying a large and profitable traffic the rebate, if required, might be of considerable value, but in such a case it would probably not be required. Whereas, if the branch line traffic were small and of little value the rebate would also be of little value, and the branch line would receive practically no assistance whatever. The Indian Government must surely have been aware of this. That those to whom the Government appealed were aware of it the result only too clearly shows. I have three reasons for fearing that the new rebate terms will be no more successful than those of 1893 and 1896. They are—(1) That while the permissible rate of interest is raised from 4 to 5 per cent., and the permissible rebate from 10 per cent. of the *gross* earnings of the main line from traffic interchanged between it and the branch line, to a sum not exceeding the *net* earnings from the same traffic, there is, so far as I know, no definite proportion fixed between the gross and net earnings. The result will be, I fear, that in branch lines where the traffic is poor, that is, where the rebate will be most wanted, the net earnings will be much less than is probably anticipated. The main line, that is, the line responsible for working the traffic, has no direct interest in keeping the working expenses low, and the net earnings decrease as the working expenses increase. (2) The position of these branch-line companies seems to me in many ways to be very unsatisfactory. They provide the capital, but they do little else. The lines are worked by the main line, and the branch line has little control. The directors and shareholders of branch lines can find little scope for business capacity or energy. They cannot hope to extend their line and to become in time the owners of an important, well-paying, self-contained railway system. They are branches to begin with and to end with, because as soon as they cease to be branches they will be absorbed into the main line, and, becoming an integral part of it, lose their separate identity. This may to some extent be sentiment, but I believe it has a not unimportant influence in preventing business men taking a more active interest in Indian railway finance. (3) What is the object of these rebate terms? Obviously it is to give a reasonable guarantee to

investors in branch lines that they will get their 5 per cent. Now Government can themselves raise money at less than 5 per cent. It is true, as the author points out, that they recently failed to raise £3,000,000 at 3½ per cent., but they got it underwritten at rates that probably work out to about 3·85 per cent. It may safely be assumed that they could easily have got the money at 4 per cent., certainly at 4½ per cent. Now why should Government offer 5 per cent. on rebate terms to branch-line investors, when they can raise the money themselves at a lower rate of interest, and pay the interest in the same way as they expect the branch lines to pay 5 per cent.? The only answer to this question that occurs to me is that Government have themselves grave doubts of the ability of the branch lines to pay 5 per cent. on the terms offered, and in consequence they consider it good business to put the risk of failure on the shoulders of others rather than to accept it themselves. Under such circumstances it seems to me that investors, both English and Indian, will show more wisdom by refusing the offer of the Government of India than by accepting it.

Mr. Priestley, to whom the foregoing letter has been submitted, writes as follows:—

Mr. Brunton gives three reasons for fearing that the 1910 rebate terms will be no more successful than those of 1893 and 1896. As his premises are not correct his conclusions are also wrong, and for the following reasons—

(1) The 1910 terms specifically limit the cost of working the branch to 50 per cent. of the branch's gross earnings.

(2) The main line is interested in working up the traffic of the branch because it divides equally with the branch all profits over 5 per cent. If, because of the extension of the branch into a through line, Government decide to take over the line before the expiry of the contract, they undertake to pay to the branch twenty-five times its average net earnings during the three years preceding the purchase subject to a *minimum* payment of Rs. 115 for every Rs. 100 of the branch's capital.

(3) It doubtless would give all the profit to Government if they raised the money and built the lines as State lines; but the financial advisers of the Government must be assumed to know their own business best, and if they find themselves unable to go to the market for a loan of all the money that is required for railway construction, there must be very good and sufficient reasons for their action. I am quite sure that there are no grounds for the very unworthy motive which Mr. Brunton attributes to Government, namely, that "Government have themselves grave doubts of the ability of the branch lines to pay 5 per cent. on the terms offered, and in consequence they consider it good business to put the risk of failure on the shoulders of others rather than to accept it themselves." I am equally sure that Mr. Brunton is wrong in the advice he offers to English and Indian investors that they "will show more wisdom by refusing the offer of the Government of India than by accepting it."

I believe, as I said in my paper, that the *terms* are on the whole good, and that lines promoted under them will prove perfectly satisfactory to investors, if the outlay is made to harmonise with the income expected; and in this view I am supported by Mr. L. R. W. Forrest, who has had larger experience than any man in India of the promotion of companies on these rebate terms.

TEA-GROWING IN RUSSIA.

The Imperial Russian Domain has an estate at Chakva, near Batoum, where successful experiments are being carried on in the cultivation of tea, oranges and other fruits, and bamboo. So far, it is said, no official reports on the results accomplished have been made public, but an exhaustive report is in preparation for an industrial exhibition to be held at St. Petersburg during 1912 and where the resources of the Caucasus will be exploited. The property consists of 43,200 acres, and covers what was formerly a hopeless tangle of rank vegetation. During the past few years a considerable portion of the territory has been cleared and improved, and has become one of the most attractive and healthful districts on the east coast of the Black Sea. The estate, according to the American Vice-Consul at Batoum, has a western frontage of about two miles along the sea. From there it stretches eastward, and is enclosed at its extreme limits by a semicircle of hills that give protection against the cold winds sweeping down from the mountains. The greatest altitude of the hills immediately surrounding the estate is about two thousand feet. The soil is principally red clay, black earth and sandstone. There is an occasional sprinkling of limestone. Tea-growing began on the estate in 1890. The most promising ground was cleared and the work put under the direction of expert tea growers. Members of the Imperial Domain's staff were sent to China, Japan, India and Ceylon to acquire practical knowledge of tea growing. Experienced growers were also brought out from China, and one of these still remains as manager of the tea plantations. Tea-growing has now passed beyond the experimental stage. The annual crop averages about two hundred thousand pounds. About twelve hundred acres are devoted to tea culture. The fields are partly on the plains and partly on the low hills, which in some cases have been terraced as a protection against erosion. During the early experimental stages about three thousand tea bushes were planted to the acre. This number has been increased, until as many as four thousand four hundred bushes are now crowded into the acre. The tea plantations are being extended at the rate of about one hundred and thirty-five acres per annum. The leaf is picked four times during the season. The first picking yields the superior quality, although the second is more abundant. The leaf is cured in a modern

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factory, where every care is taken to obtain cleanliness. The cleaning, curling and packing are all done by machinery, which is mostly English. The sanitary conditions are excellent. The Chakva tea somewhat resembles in taste the teas of Ceylon and India, although it cannot be said as yet to have reached the excellence of the best of these. The Russian tea is sold principally in Poland and Central Asia. Shipments of about one thousand pounds have been sent to America on one or two occasions, but no regular demand appears to have followed.

PRODUCTION OF SILK IN FRANCE.

The production of silk and the number of sericulturists engaged in this industry in France, appear to have fallen off considerably during the last few years, judging from the following statistics published by the Minister of Agriculture:—

Year.	No. of Sericulturists.	Weight of Raw Cocoons.	
		Kilogs.	Lbs. avoirdupois.
1907	124,463	8,396,202	18,513,625
1908	123,804	8,409,299	18,542,504
1909	119,067	8,546,526	18,845,090
1910	114,283	4,269,709	9,414,708
1911	102,605	5,109,426	11,266,284

The principal departments in which this industry was carried on last year, and their production of raw cocoons, are given in the order of their importance:—

Department.	Kilogs.	Lbs. avoirdupois.
Gard	1,341,706	2,958,461
Ardèche	1,129,672	2,490,926
Drôme	962,122	2,121,479
Vaucluse	560,140	1,235,110
Var	327,745	722,678
Isère	234,974	518,118
Bouches-du-Rhône .	127,474	281,080
Basses Alpes . . .	116,772	257,482
Other Departments .	308,821	680,950
	5,109,426	11,266,284

THE PALM-SAP INDUSTRY OF THE PHILIPPINES.

The aboriginal Philippine tribes for hundreds of years—probably since long before the advent of white people among them—have made alcoholic drinks from the saps of certain palms, among them the nipa palm, the coco-nut palm, the sugar palm, and the buri palm. It has long been known that the sugar possibilities of some of these palms merited investigation. In fact, investigations into the sugar possibilities of some of them have been made in past years, notably into the merits of the coco palm in Ceylon and the sugar palm in Java, while sugar is now actually made from the coco palm by the natives of the Philippines. According to the returns of the Internal Revenue Bureau of the Philippines, about 93 per cent. of the entire output of alcohol and alcoholic beverages produced in the Philippines in 1910 came from the sap of palms, the production noted by the authorities amounting to about 2,062,000 proof gallons. The industry is greatly on the increase. About twenty-two beverages are manufactured from these saps. As a rule they are well-known native drinks, or imitations of well-known foreign drinks. The most popular, known as anisette anisado, vino de coco, and vino de nipa, contain 10 to 55 per cent. of alcohol. In addition to the above, a vast amount of palm sap is consumed without distillation. Nevertheless, the production of alcohol from these palm saps is developed to only a fraction of its possibilities. There are not only vast areas of palms suited to the production and accessible, which are yet untouched, but the cost of production, under even present crude conditions, is small, compared with the cost of producing alcohol from other sources. From the standpoint of alcohol production and of sugar production, the principal palm is the nipa palm. The nipa is an erect, stemless palm, of which the leaves and infloresence rise from a branched root stock, the leaves running from nine to thirty feet in length. It grows along the tidal marshes of rivers in low, wet lands, subject to overflows of brackish water as the tides rise each day, and it will not thrive where either fresh or sea water alone is available. Nipa swamps of considerable size occur practically throughout the Philippines, and, inasmuch as they occur in lands which otherwise are useless or almost without value, the cultivation of nipa palms where they are cultivated, or the presence of nipa trees wild where not cultivated, affords a profitable crop on little original outlay. The sugar-making possibilities of these saps, considered commercially, seem to hinge largely upon conditions under which the sap can be gathered and handled. The saps of the three principal sugar-bearing palms, the nipa, the coco, and the buri, run remarkably close together in composition. The sap from these trees, as a rule, is obtained through the flower stalk. In the nipa the flower stalk is cut off immediately below the fruit. It is generally tapped the fifth year. Each

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day a thin slice is cut from the severed stem, to keep the wound fresh and facilitate the flow of sap. The sap is collected in bamboo joints hung on the stem, generally having a capacity of about two quarts. One stalk normally flows about three months, but it is not uncommon for it to be cut entirely away by the thin slices, from day to day, long before the flow has ceased. In some districts the plant is cut before the fruit forms, and the flow of sap is increased thereby, so far as daily output is concerned, but the length of the flow is shortened—the total yield of the plant apparently being about the same by either method. The plants are allowed to rest and put forth new fruit stalks, after being thus exhausted. How long they continue to bear is uncertain, but all authorities agree that a plant will continue to produce sap for many years, probably for fifty years or more, on an average. The yield of sap also is uncertain, and estimates vary between wide limits. An experienced distiller says that each plant will average about three pints daily. The yield and quality of the sap can be improved by seed selection and a measure of cultivation of the plant. The sap, as it flows, is clean and almost colourless, and very sweet to the taste. Fermentation commences so soon after the sap exudes that many distillers believe that yeast germs are present in the sap; but the immediate fermentation is explained, to some extent, by the fact that the receptacles for the sap are used, over and over again, without cleaning. When the sap is collected in clean vessels it undergoes no change for four or five hours.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Colonial Cotton.—A contribution of 75,000 bales of cotton goes but a short way towards the annual need of 18 million bales. Even the 100,000 bales which the British Cotton-Growing Association hopes to be raising in two or three years' time bulks hardly larger against the vast requirement of the world's spinning mills. Were this the sole outcome of nine years of labour, the sinking of hundreds of thousands of money and the raising of thousands of hopes, the failure might be written down as tragical. The fruits of the effort are fortunately very much larger, and although the time is not ripe to value them, some of their flavour can be appreciated. For one thing the association has determined authoritatively which parts of Africa are definitely unsuitable for cotton culture. The discovery has been made by costly experiment under the most skilled advice, and the proofs should be the means of saving future disappointment. The most favourable districts have been sorted out, their soil has been examined, and their special suitability to seed of one kind or another has been duly recorded. Native cultivators have been trained, and a market for seed cotton has been guaranteed to them. Ginneries have been established, and a cotton-growing industry has been set afoot in the best circumstances to ensure its continuance. The efforts have had excellent effects in stimulating other Governments to attend to cotton culture, and in reminding Americans that Europe is not content to rely too much on one source for its cotton supply. Negatively and positively, indirectly and directly, the outcome of the nine years amounts to very much more than a total production of three millionsworth of cotton. The British Government is a partner in the work and contributes £10,000 a year, under an agreement which expires in March next.

The late Sir Alfred Jones used to prophesy that Northern Nigeria would ultimately supply all Lancashire's needs. It supplied last season 2,500 bales, and the prospects are called splendid by the chairman of the association. Lagos yields 10,000 and Uganda 19,000 bales; there are besides Rhodesia, South Africa, Nyasaland, and the West Indies. India falls to the Indian Government's care, and in search of a really large new field the Cotton-Growing Association now addresses itself seriously to the Sudan. Money is wanted in sums commensurate with the possibilities of the area, and the British Government is asked for £200,000 as a grant in aid, and £1,000,000 upon loan for irrigation. The Sudanese scheme has the backing of eminent and responsible opinion in Lancashire, and the sympathy and interest of Lord Kitchener in Egypt.

Shuttle-kissing.—The practice of "shuttle-kissing," which has been reprobated but not utterly condemned by an inter-departmental inquiry, may be likened to stamp-licking. It is the most immediate and, at the same time, most unhygienic means of attaining a given result. The cotton or linen weaver seeking to draw the weft yarn through the shuttle's eye applies the shuttle to her lips, makes a sharp inhalation and so sucks out the thread. The weaver performs the act usually and may do it four or five hundred times a day in some circumstances, but there is a measure of promiscuity in shuttle-kissing. The male overlooker will kiss the shuttle when starting the loom, and the weaver's tenter, or assistant, will occasionally put the shuttle to her mouth. There is every probability that transmissible disease can be propagated by the shuttle, but the investigators have found no cases of infection proven. Particles of dust, dye, size and fibre are unquestionably brought into the mouth and throat, and perhaps into the lungs. The habit is highly probably a cause of the dental caries that is often conspicuous among weavers, but the evidence does not in sum impel the investigators to recommend England to follow Massachusetts and declare shuttle-kissing illegal. Their decision may well be disappointing to the considerable number of inventors who have been at pains to devise arrangements to supersede the human lips. The systems proposed by different patentees are several, ranging from simple syringes up to suction air-pipes, and including shuttles with

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slits or eyes through which the yarn cannot be sucked. It is all too likely that shuttles which can more conveniently be kissed than mechanically threaded will be treated in the primitive manner, despite doctors, factory inspectors, laws and employers.

Indigo Dye.—The Textile Institute is addressing itself to the problems surrounding the use of the words "indigo" or "real indigo" on dyed cloth, with some view to standardising the term. A Scottish court has decided that the law cannot support the use of this word on goods into which no indigo enters, but otherwise all is vague. Apparently anything is indigo if the smallest part of that dye is used in its manufacture. There are blue wool serges that are indigo by courtesy of having passed through a spent indigo vat, and others that owe their title to the name purely to any such indigo as may have been used in dyeing the blue rags from which they have been manufactured. Does "indigo" imply vegetable indigo, or may it be applied to the indigotin synthesised from coal tar, which is much more used in these days than the leaf product? Can the word be justly used of any colour which responds to the accepted chemical tests? These are some of the points resting to be cleared, and it is worth observing that the dyeware manufacturer is able now to baffle most of the accepted tests. Once, the suspicious buyer was wont to rely upon the lemon-coloured green-ringed spot produced by putting a drop of cold nitric acid upon the cloth, but long before synthetic indigotin was a commercial product there were cheap blues sold to satisfy this test.

Real indigo has undoubted virtues in "feeding" the cloth upon which it is used, in withstanding exposure to all kinds of climatic conditions, and in rejuvenating its own colour after fading. The blue recovers its bloom if the garment is left to hang in the dark. To set against these advantages are the expense and the liability to rub or, as dyers say, to "crock." It is fair evidence that a blue is real indigo if the wearer's linen collar is blue-stained every time he wears the coat, and if the blue marks a handkerchief or screw of white paper when rubbed on the cloth dry. Just because indigo does "crock," and because the better the indigo the more the crocking, some highly expensive goods are dyed with alizarin blue. These cloths, which go to South America and other tropical countries, lead to no complaints of fading and none of rubbing.

Paper Yarn.—Paper yarn is perhaps best known to the public in the form of twine, although certain other uses have been found for it. To make it, paper is taken in such reels as are used in newspaper printing, and these are slit into ribbons which are twisted to form a continuous round thread. The thread may be glazed or polished for use as parcel twine, and be reinforced inwardly with a thread of flax. The article has appeared as a substitute for jute in making bagging; it has been used for insulating electrical wires, and for making a backing or foundation for cheap carpets. These are the more commercially practicable purposes to which paper yarn has been put, although it has been exhibited in some other connections. Coarse mattings resembling cocoanut matting, white duck serviceable for shoe-uppers, woven towels for steamship use, webbing for the ends of braces and for upholstery, are some of the less far-fetched employments that have been proposed for it. By way of *tour de force* it has been shown that paper thread can be used underneath a facing of silk to make hatbands, and that passable imitations of Irish tweed can be woven with alternate threads of shoddy and paper. These varied capabilities have not averted financial troubles from some of the producers, and the total production, viewed on the general scale of textile things, is small. Opinions may vary as to which is the greatest among the natural defects inherent in a coagulated mass like paper yarn, but an obvious one is sheer thickness. Four's cotton counts (840×4 yards per lb.) are fine in paper yarn, and 6's or 8's are the finest counts mentioned as practicable. In the cotton trade, 40's are reckoned a coarse count, and the best cotton spins to 300's. By no possible means can coarse yarn fill the place of fine. The deadness and inelasticity of paper, its softness when wet, its liability to fray when dry, the ready fading of its colours, and half a dozen other considerations, incapacitate paper from competing on level ground with the fibrous materials, and restrict its use to a narrow textile sphere.

English Wool.—Another difficult year is expected by dealers in the English clip. The British farmer stands firmly to his prejudices in favour of high prices, and refuses to be daunted by the demonstrable fact that Colonial crossbred wool of sorts closely resembling his own is being dealt in at substantially lower prices. It is little to him that dealers have not for two seasons past made more than their living expenses. He is aware that wool is grown in Australasia and South America on sheep of his own breed and strain, and that this arrives in large quantities, carefully packed, regular in quality and requiring much less sorting and manipulation than his own. The facts are an old story, and time only makes it more clear that British-grown wool of nominally the same quality possesses some superior attractions that are to be set against its manifest disadvantages. The wool is more "lofty," as the expressive term goes for bulkiness and springiness, and it is more lustrous. For its own range of purposes the home supply is unexcelled, and no imported wools exactly fill its place. The farmer has an incentive to be firm this year in his knowledge that the clip—at least of hogg wool—will be short. Last year's dry summer, with its consequent lack of winter feed, induced many farmers to part with the lambs that would have normally become yearlings. Hogg

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(*i.e.* first) wool will doubtless be dear relatively to wether wool (the produce of animals which have been previously shorn), and it will assuredly pay growers to pack the two kinds separately.

CORRESPONDENCE.

COLONIAL VINE CULTURE.

It does not seem to be sufficiently appreciated in this country that the climatic conditions and soil over large areas in Canada have been demonstrated to be as highly adapted for vine culture as the best known vineyard districts in Europe which have a world-wide reputation. Fruit-growing in Canada in the popular mind is associated with the raising of apples, pears, and the hardier fruits. It is true grape-growing at present is perhaps of local rather than of national importance; but of the possibilities to be realised in the cultivation of the vine in Canada there can be no question. Grape-growing centres in the province of Ontario, whose vineyards cover 12,000 acres. This province has a larger variety of local climate than any other country of similar extent in the world, due to the influence of the Great Lakes and to the hydrographic system of the interior. Between the north shore of Lake Superior and Lake Erie the summers vary from those of Scotland to those of central and much of southern France—summers as warm as in northern Italy and warmer than the coast of Portugal. The most favoured sections lie along the shores of Lake Ontario and Lake Erie, including the Niagara Peninsula. According to expert opinion, there is an area of some 9,000 *square miles* in Ontario where even peaches of one kind or other can be successfully grown in the open air, while in the whole valley of the St. Lawrence there is an area of probably 30,000 *square miles* where the soil and climate are suited for the vine. The Niagara district and the counties along Lake Erie are the natural home of the famous Concord grape-vine, the variety with which the vineyards of France and Italy and other countries have been re-stocked after the ravages caused by phylloxera. In this region the counties of Lincoln, Wentworth, and Welland are mainly identified with grape-growing, and have a total annual output of from 20,000 tons. The vine begins bearing at four years, and continues for a lifetime. The vines are grown on trellis supports. Good grape land is plentiful. In the most favoured districts it may be purchased at from £16 an acre.

The figures furnished by the Ontario Government of the cost of maintenance and the profit per acre are as follows:—Cost of bringing an acre of grapes into full bearing, including supports for vines, £15; annual outlay per acre when bearing (pruning and tying, cultivation, spraying three times, picking, and packages and delivery to stations), £12; average yield, three tons (or 750 baskets, average price 7½*d.*), £23 (a yield of five tons per acre is frequently obtained); net return per acre, £11.

Grapes for the table are mainly raised; but about one-third of the grape crop is devoted to the manufacture of wine, the annual output being 300,000 gallons, for which purpose the grower is able to dispose of his crop at from £3 14*s.* to £7 8*s.* per ton, and finds it a profitable method, as everything can be shipped. Plants for wine manufacture exist at St. Catharine's, Hamilton, Stanford (near Niagara Falls), and at Sandwich and Pelee Islands in Essex Co. The markets for table grapes are Toronto, Hamilton, and other neighbouring cities. Grapes are also shipped by the carload to the western and eastern provinces. It may be pointed out that grape-growing at present is conducted in connection with other forms of fruit-growing, and with the raising of vegetables and tobacco. Mixed horticulture of this character is growing very rapidly in Ontario, and attracting large numbers of people from this country who prefer intensive cultivation on small areas amid the amenities and comforts of life in well-ordered and settled districts to the possibly more profitable openings to be found under pioneer conditions in Western Canada. C. F. JUST.

NOTES ON BOOKS.

MODERN COTTAGE ARCHITECTURE. Selected and Described by Maurice B. Adams, F.R.I.B.A. Second Edition. London: B. T. Batsford. 10*s.* net.

In preparing this volume, Mr. Adams has selected with great care a series of views and plans representing practically every type of cottage—"single cottages, cottages in pairs and in rows, gardeners' cottages, bailiffs' cottages, week-end cottages, a nurse's cottage, a doctor's cottage, a cottage hospital, and a cottage home, lodges, gate-entrances, etc., built in stone, brick and half-timber, with roofs in thatch and tiles, and walls tile-hung or rough-cast." The designs include the work of most of our best-known architects, *e.g.*, Sir Aston Webb, Sir Ernest George, Sir R. S. Lorimer, Messrs. E. L. Lutyens, A. N. Prentice, Guy Dawber, Leonard Stokes, the Editor himself, and many others. In this, the second edition, the number of illustrations — which are admirably reproduced—has been largely increased, so that there are now no fewer than 83 full-page plates from photographs and drawings, and 54 illustrations of plans, elevations, etc., in the text.

Mr. Adams contributes an introductory chapter entitled "Notes concerning Cottage Building," in which he gives some useful hints as to planning, arrangement, and fitting generally; but the most valuable part of the book, no doubt, consists in the illustrations, which represent types of cottages suitable for almost every part of England and Scotland. Anyone who meditates building a cottage of whatever description would do well to start operations by consulting this interesting and suggestive book.

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STEAMSHIP NAVIGATION. By H. T. Arnold. London: Blackie & Son, Ltd. 1s. 6d.

In this little handbook, Mr. Arnold gives a brief but very clear account of the elements of steamship navigation. After a section of definitions, he describes various patent ship-logs, Walker's current meter, and Lord Kelvin's sounding machine. Chapter II. deals with swinging the ship and the correction of courses; Chapter III. with the differences of latitude and longitude, and the succeeding chapters with plane sailing, traverse table and traverse sailing, parallel sailing, middle-latitude sailing, Mercator's sailing, the day's work, and, finally, the construction of a Mercator's chart. A number of practical examples and examination tests are given, which should make the book useful to students in nautical schools.

GENERAL NOTES.

ROYAL LOAN OF INDIAN OBJECTS TO THE VICTORIA AND ALBERT MUSEUM.—The King and Queen have been graciously pleased to lend to the Victoria and Albert Museum an important series of Indian objects, including caskets and addresses presented to their Majesties on their recent visit to India, and gifts from the Maharaja of Nepal, the Begam of Bhopal, and the Sultans of Lahej, and of Shehr and Mokalla. The collection has been arranged in Room 1 of the Indian section, where it will remain on view until further notice. The caskets, designed to contain the addresses presented to their Majesties, are of native manufacture in a style which is largely European. The most important is that presented by the Municipal Committee of Delhi; this is in ivory, with panels beautifully carved with scenes illustrating the Ramayana, one of the great epic poems of the Vedic age. Another interesting casket is that of the Presidency of Madras, consisting of a rectangular structure in silver supported on kneeling elephants, and surmounted by peacocks with enamelled plumage. The gift of the Municipal Corporation of the City of Bombay, also of silver, suggests in form a Dravidian temple, flanked by domes of Mohammedan type. The casket from the Begam of Bhopal is the model of a river boat with eight rowers and a steersman; it is in silver-gilt with a string of small jewels along the gunwale. The present from Nepal consists of a variety of objects in which figure interesting specimens of native wood-carving, brasswork and gold jewellery. With one or two exceptions, these are skilful products of the Newar craftsmen, the race of mixed Indian and Mongolian origin which formerly supplied Nepal with a dynasty of Rajas overthrown by the Gurkhalis in 1767. The miniature windows, intricately carved in Himalayan red birchwood, illustrate what is at present the most important form of Nepalese decorative art.

FERTILITY OF THE SOIL.—In a paper on "Recent Advances in Agricultural Science," with particular reference to the fertility of the soil, recently read before the Royal Institution, Mr. A. D. Hall, F.R.S., said that the fertility of the soil was the outcome of a very complex series of factors, including the actual supply of plant food in the soil, its mechanical texture as conditioning the movements of water, and the particular micro-fauna and flora inhabiting the soil, for upon these lower organisms depended the facility with which the material contained in the soil became available for the nutrition of the plant. Dealing with the question of the duration of the fertility of the land under continual cropping, the lecturer said that the United States had begun to take alarm about the reduced production of some of its most fertile lands, as, for instance, the old prairie lands of the Middle West—a reduced production which, among other causes, had helped to set in motion a stream of migrants from the United States to the newer lands of the Canadian North-West. In the development of agriculture three distinct stages might be observed. There was the pure exploitation of the initial resources of the soil, when the farmer was to all intents and purposes mining in its fertility. This was the process which had been going on in America and in all the newer countries. Farming of that kind was destructive; but in the older lands of the west of Europe, which had been long under cultivation, a conservative system had been devised which was capable of keeping up the productive power of the soil, though not, perhaps, to a very high pitch. The best example of this could be seen in the Norfolk four-course rotation before the introduction of artificial fertilisers. This conservative farming, about 1840, began to give place to the third stage in the development—intensive farming —rendered possible by the discovery of artificial fertilisers and the cheap freights which brought cheap feeding-stuffs to the soil of this country. By these means the average production of the land of the British Isles had been raised from the twenty bushel level to something over thirty bushels, and the most intensive farmers reached an average level at least 25 per cent. higher. In their case the soil had become practically a manufacturing medium, transforming the nitrogen and other fertilising materials added to it into crops, giving nothing to those crops from its original stock, and, indeed, up to a certain point gaining rather than losing fertility with each year's cultivation. The research work of Doctors Russell and Hutchinson at Rothamsted justified them in believing that they could so rearrange the micro-fauna and flora of the soil as to obtain a much higher duty from the reserves of nitrogen contained in them.

COTTON IN SIAM.—It was thought at one time that cotton might be profitably grown in Southern Siam, but recent experiments are not very encouraging. A Japanese syndicate was formed with the object of cultivating cotton, but its operations have not been successful, and the local exhibits at

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the recent exhibition of agriculture and commerce in Bangkok were pronounced to be generally poor. Mr. Acting-Consul Crosby, in his report on the trade of Bangkok, seems to think that the introduction of superior varieties from other countries may be productive of good results, but the high cost of labour is a severe handicap to planters. Experiments have been tried with Egyptian cotton, but the results have not been very satisfactory, the staple turning out little better than that of local varieties. It may be noted that of the imports of cotton goods the United Kingdom and Singapore contributed, last year, 36 and 35 per cent. respectively.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 3...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m.

Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Dr. H. E. Armstrong and Mr. R. T. Colgate, "The Nature of the Process of Oxidation (with demonstrations)." 2. Mr. E. G. Clayton, "Some Present-day Aspects of the Match Industry."

Actuaries, Staples Inn Hall, Holborn, W.C., 5 p.m. Annual Meeting.

Victoria Institute, 1, Adelphi-terrace, W.C., 4.30 p.m. Ven. Archdeacon Beresford Potter, "The Influence of Babylonian Conceptions on Jewish Thought."

Surveyors, 12, Great George-street, S.W., 5 p.m. Annual General Meeting.

TUESDAY, JUNE 4...Royal Institution, Albemarle-street, W., 3 p.m. Professor W. M. Flinders Petrie, "The Formation of the Alphabet." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m. Mr. W. R. Caesar, "Mont Blanc by the Brenva and other Traverses in 1911."

Photographic, 35, Russell-square, W.C., 8 p.m. Mr. H. W. Bennett, "Minor Difficulties in Architectural Photography."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. E. G. B. Meade-Waldo will introduce a discussion on "The Preservation of the English Fauna." 2. Mr. R. Lydekker, "The North Rhodesian Giraffe." 3. Professor S. J. Hickson, "On the Hydrocoralline Genus *Errina*." 4. Dr. Frank E. Beddard, "Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. VI.—On an Asexual Tapeworm from the Rodent *Fiber zibethicus*, showing a new form of Asexual Propagation, and on the supposed Sexual form." 5. Helen L. M. Pixell, "Polychæta from the Pacific Coast of North America. Part I.—Serpulidæ, with a Revised Table of Classification of the Genus *Spirorbis*." 6. Dr. R. Broom, "On some new Fossil Reptiles from the Permian and Triassic Beds of South Africa."

WEDNESDAY, JUNE 5...Geological, Burlington House, W., 8 p.m.

Public Analysts, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., 8 p.m. 1. Mr. H. D. Richmond, "The Composition of Milk." 2. Messrs. A. Chaston Chapman and Alfred Siebold, "On the Application of Adsorption to the Detection and Separation of certain Dyes." 3. Mr. W. F. Lowe, "The Estimation of Dirt in Milk." 4. Mr. E. H. Miller, "A New Method for the Detection and Estimation of Small Quantities of Nitrous Acid." 5. Mr. F. S. Sinnatt, "A Further Note on the Use of Methylene Blue as an indicator in Iodimetric Titrations." 6. Dr. K. J. P. Orton, "The Estimation of Nitric and Nitrous Acids in Acetic Acid Solution. The Stability of Nitric Acid in Acetic Acid Solution."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m.

THURSDAY, JUNE 6... Water Engineers, Institution of, Town Hall, Cheltenham (Summer Meeting), 10 a.m. 1. Address by the President, who will also supply "Description of the Cheltenham Corporation Waterworks." 2. Dr. S. Rideal, "The Pre-Filtration Process now being introduced at the Tewkesbury Works." 3. Selection from the following papers :— (*a*) Mr. P. Griffith, "The New Waterworks for Skegness"; (*b*) Mr. D. Dinwiddy, "The Rating of Water Undertakings"; (*c*) Mr. A. Valon, "The Rating of Water Undertakings"; (*d*) Discussion upon "The Desirability of Standardising the 'General Conditions of Contracts,'" introduced by Mr. H. W. Woodall; (*e*) Mr. E. H. Crump, "The Hinckley Waterworks"; (*f*) Mr. R. Read, "The Gloucester Waterworks (Witcombe Reservoirs)"; (*g*) Mr. G. Embrey, "The Use of Sulphate of Copper in purifying Water Supplies"; (*h*) Dr. J. H. Garrett, "The Self-Pollution of Water by Natural Growths"; (*i*) Mr. L. Richardson, "The Geology of Cheltenham with special reference to the Water Supply."

Linnean, Burlington House, W., 8 p.m. 1. Professor A. Meek, "The Development of the Cod, *Gadus morrhua*, Linn." 2. Mr. E. J. Bedford, "Lantern-slides of Orchids recently observed in Sussex." 3. Mr. C. Hedley, "Palæontographical Relations of Antarctica." 4. Mr. R. Vallentin, "Lantern-slides illustrating the Fauna and Flora of the Falkland Islands."

Chemical, Burlington House, W., 8.30 p.m. 1. Mr. J. E. Purvis, "The Absorption Spectra of Various Derivatives of Naphthalene in Solution and as Vapours." 2. Mr. J. Kendall, "The Velocity of the Hydrogen Ion, and a General Dissociation Formula for Acids." 3. Messrs. F. D. Chattaway and A. E. Swinton, "Chloroamino Derivatives of Benzylidene Diamides." 4. Messrs. T. S. Price and D. F. Twiss, "The Refractivity of Sulphur in various Aliphatic Compounds." 5. Messrs. H. M. Dawson and F. Powis, "The Conditions of Iso-Dynamic Change in the Aliphatic Ketones. I.—The Auto-Catalytic Reaction between Acetone and Iodine." 6. Messrs. C. Smith and W. Lewcock, "Pyrogenic Decompositions. I.—Benzene." 7. Messrs. P. C. Ray, N. Dhar and T. De, "Vapour Density of Ammonium Nitrite." 8. Messrs. H. Stephen and C. Weizmann, "Tyrosin and its Derivatives Containing Substituents in the Benzene Ring." Preliminary note.

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. G. Barkla, "X Rays and Matter." (Lecture II.)

FRIDAY, JUNE 7...Waterworks Engineers, Institution of, Town Hall, Cheltenham. Summer Meeting (continued).

Royal Institution, Albemarle-street, W., 9 p.m. Sir William Macewen, "Lord Lister."

Municipal and County Engineers, Institution of, Albert Hall, Stirling (Scottish District Meeting), 11 a.m. 1. Reception. 2. Discussion on paper by Mr. A. H. Goudie, "The Municipal Works of Stirling." 3. Discussion on paper by Mr. D. R. Cox, "Work carried out in Central Stirlingshire under the Road Development Grant."

SATURDAY, JUNE 8...Waterworks Engineers, Institution of, Town Hall, Cheltenham. Summer Meeting (continued).

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. L. Moore, "The Weather and the Utilities of Forecasts."

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Journal of the Royal Society of Arts.

No. 3,107. VOL. LX.

FRIDAY, JUNE 7, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

THE SOCIETY'S ALBERT MEDAL.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of His Royal Highness the President, to the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S., for his services in improving the railway communications, developing the resources, and promoting the commerce and industry of Canada and other parts of the British Empire.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, May 21st, 1912; The Right Hon. Lord Emmott, Under-Secretary of State for the Colonies, in the chair.

The Chairman, in introducing the reader of the paper, said Mr. Jenkins had performed many services to the State of South Australia and to the Empire. He was Prime Minister of South Australia for four years, and was subsequently Agent-General for that State in this country for another four years. Before he filled those high offices he was Minister for Works for some years, and during that time had great experience of railways, and made a special study of them. The audience, therefore, would hear a paper of great interest.

The paper read was—

AUSTRALIAN RAILWAYS.

By The Hon. J. G. Jenkins.

After I consented to read a paper on Australian Railways, one of my friends said to me: "Why in the world did you choose such a subject? You must have known that it was dry and unattractive, and would be most uninteresting to anyone who would be foolish enough to go and listen to you." Buoyed up by such encouragement, I decided to continue the paper.

There are three reasons why I have selected this subject, dull and dry though it be. In the first place, it is a subject in which I have for many years taken a special interest, partly by choice and partly by compulsion, as I was for nearly twenty years interested in every railway proposal or Bill which was brought before one of the Australian Parliaments, and was for over six years the Ministerial head of the railway department.

In the second place, my experience during several years in this country has on many occasions convinced me that there is a great lack of knowledge by the general public in respect to the relations between the indebtedness of Australia and its public undertakings, such as railways, wharves, waterworks, etc.; and the third reason is that the energetic Secretary considered the subject a good one, and his judgment and experience is beyond dispute.

Area and Population.

In dealing with Australian railways, it may be necessary to refer for a moment to the country's location, extent, physical features, and climatic conditions.

We have a continent island, lying at the other end of the world, over 10,000 miles from the kingdom from which 95 per cent. of its population has descended; having an area of about three million square miles and a coast-line of over 12,000 miles, with for the most part a fringe of hills or low mountains not far from the coast, with vast plains and table-lands broken by occasional hills in its expansive interior, with a variety of climate, tropical, semi-tropical, and temperate, a rainfall varying according to locality from five to nearly 200 inches, rich soil, and glorious sunshine.

Such, in brief, is Australia, with a population of $4\frac{1}{2}$ millions of people, or only one and a half for every square mile of land, while here in the

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United Kingdom we have 366 for every square mile.

These are facts which have to be noted when dealing with a country's railways.

Construction of First Railway.

The first railway was started in New South Wales in 1850 by a private company, but the discovery of gold in different parts of Australia about this time caused a general rush of nearly every able-bodied man to the goldfields, so the private company were not able to complete their railway. The same thing happened with one or two private companies in Victoria about the same time, and in both Colonies appeals were made to the authorities, and the lines were taken over and completed by the respective Governments, so it is more than likely that the State-owned railways of Australia are the result of the gold discoveries, for from these early experiences other lines were proposed and constructed by the Governments of the different States, and the national system has grown up with the population.

A few private lines have been built, but they have mostly been purchased by the Governments. So, in speaking of Australian railways, it is generally understood that one means Government-owned lines.

Slow Growth and Cost.

For many years the railway growth was very slow. In 1855, five years after the commencement of the first line, there were only twenty-three miles in all Australia, and during the next sixteen years, up to 1871, there were only 220 miles more added. From 1871 to 1891, however, 9,000 miles were constructed, and each year since has added to the mileage, until on the 30th June last year there were about 17,000 miles of Government railways, which had cost about £155,000,000, or an average of a little over £9,000 per mile.

When this is compared with the great expense of railway construction in this country, it is easy to see that the money spent on railways in Australia is bound to earn a good return as population and settlement increase.

Some of the Australian lines have been rather expensive, the dearest one being from Melbourne to Bendigo, one hundred miles, which was built just fifty years ago at a cost of £48,000 per mile. On the other hand, many lines have been built in the different States at less than £2,000 per mile, and I believe one or two lines in West Australia have only cost about £1,000 per mile. These cheap lines have been the means of opening up and developing large tracts of country which would otherwise have remained unoccupied.

The money for the construction of the railways has been mostly raised by loan in this country, each particular State dealing with its own lines and becoming responsible for the money borrowed.

Negotiations for Control.

On several occasions since the establishment of the Commonwealth Government, negotiations and discussions have taken place between the Federal Government and the States to see if arrangements could be made for the State loans to be taken over by the Federal Government, giving that Government the receipts from the railways, and in a sense a kind of general control. So far no successful basis has been arrived at, and until the Federal authorities become more national and practical, and less sectional and political, it is considered that the States will act wisely to retain the responsibility and the control.

A mutual understanding has existed for years between the Railway Commissioners of the different States, and the most harmonious relations prevail.

Details of each State.

The mileage, cost, and earnings of the railways in each State are of special interest, more particularly to those who are holders of Australian bonds.

New South Wales has 3,760 miles of Government railways, which have cost £51,000,000, or an average of £13,550 per mile. The gross earnings last year were £6,042,000, and after paying working expenses and full interest on capital, there was a surplus to pay into the State Treasury of £554,000. This was not an exceptional year, for during the six years ending June 30th, 1911, there was a net surplus of over £3,000,000.

In Victoria there are 3,528 miles of railways, which have cost £44,200,000, or an average of £12,500 per mile. The gross earnings for the year ending June 30th, 1911, were £4,900,000, and after paying working expenses, interest on capital, and over £100,000 for pensions and gratuities, they had a net profit of £283,000, and for the six years ending June 30th, 1911, they had a net surplus of over £900,000.

South Australia has 1,457 miles of railways, which have cost £12,680,000, or an average of £8,700 per mile. The net surplus last year was £312,000, and for the last six years it was £1,388,000.

Queensland has 4,248 miles of railways, the most of any one State; they have cost

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£27,300,000, or an average of £6,425 per mile. Total revenue for year ending June 30th, 1911, £2,882,000; net surplus, after working expenses and interests, £163,500; net surplus for the previous year, £218,000. For some years previous the returns had not been sufficient to pay full interest after working expenses.

Western Australia constructed its first railway in 1879, for the development of the copper mines in the Northampton district; since that time the discovery of rich mineral fields has been a great impetus to railway construction. Up to the 30th June, 1911, there were 2,633 miles of Government railways open for traffic; they had cost £12,000,000, or about £5,000 per mile, being the cheapest in any of the States. The gross revenue for the year was £1,844,000, after paying working expenses and interest on capital, leaving a net surplus of £224,500, and for the six years ending June 30th, 1911, £884,000.

Tasmania has 463 miles of railways, which have cost £4,000,000, or an average of £8,650 per mile. Tasmania is the only State that has not in recent years been earning a net surplus over and above working expenses and interest on expenditure, but her losses have been small in comparison with the profits in the other States, and the prospects of further traffic over the railways there are encouraging. The railway manager in his last report says:—

> "At the time of writing there is great activity on the west coast lines consequent on the resumption of work at the Zeehan smelters, and there is also a marked improvement in the traffic on the western and main lines. Reports from all districts are very encouraging as to the coming harvest, and I confidently anticipate a large increase in revenue for the current year."

Taking the railways in the Commonwealth as a whole, the net surplus over working expenses and interest on capital for the last six years has been over £4,200,000.

It seems, therefore, that there need be no doubt about the safety of the money lent to Australia for railway construction.

Australia's Debt.

When Australia's indebtedness is referred to as so much per head of the population, without explanation it looks as if it was a debt-ridden country; but when it is explained that out of the entire indebtedness of between 250 and 260 million pounds, 25 per cent. of it is lent by its own people, whose knowledge of the security is first-hand, and that 155 million has been spent on railways which have paid back to the revenue in surplus profit an amount of over £700,000 each year for the last six, the national debt appears in a different light.

Besides this, wharves, waterworks, electric tramways, and other public undertakings are returning a fair rate of interest and increasing in value each year.

While referring to assets, it might not be out of place to mention, without dealing with the immense wealth of pastoral, agricultural, manufacturing, and mining industries, that the people have sufficient money deposited in the Savings and other banks to pay off the entire cost of the railways, and still have about twenty million pounds to spare for holiday and travelling expenses.

Railway Administration.

The Australian States have adopted a somewhat uniform system so far as the administration of their railways is concerned.

Prior to 1888, New South Wales railways were vested in the Minister for Works; in that year an Act was passed to place the control under Railway Commissioners, in order to free them from political influence. Three Commissioners were appointed, but the triple-headed control did not prove altogether satisfactory, so one Chief Commissioner was appointed under an amended Act of 1906.

In Victoria, even at an early date, the necessity for removing the control from political influence was felt, and in 1883 Commissioners were appointed by Act.

Queensland and South Australia adopted the same system in 1888.

Western Australia in 1902 followed the example of the eastern States, and placed its railways under the control of a Commissioner.

In Tasmania, where the Government railways are not extensive, the control was, until recently, vested in a Minister, but the Act passed last year followed the example of the other States, and placed the control under a Railways Commissioner.

No one can doubt the wisdom of placing the control and management of the railways under Commissioners instead of allowing them to remain under political control.

Of course, railway matters are still discussed in Parliament, for no line can be constructed without an Act authorising it; money can be voted only by Parliament, and important regulations and alterations of rates have to be laid on the table of the House for a time before they become effective.

All this gives members who represent railway

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districts ample opportunity of mentioning real or supposed grievances, and generally talking to their constituents at the public expense, an art not unknown even at Westminster.

CONSTRUCTION.

Time will not permit of my dealing with the engineering and other difficulties in the construction of the railways. From what was previously stated, that a fringe of hills or mountains in many places separates the coast from the interior, it will be seen that much expense and skilful engineering were necessary for the construction of many of the lines. Special mention might be made of those leading out of Sydney, west over the Blue Mountains, north over the Hawkesbury River, and south through the Bulli Pass. The Toowoomba line in South Queensland, and the Cairns line in the north, were by no means easy to construct; neither was the line leading through the hills from Adelaide towards Melbourne.

Of course, there are no curves on the Australian lines so sharp as they are supposed to be on American tracks, where the brakesman on the back car is said to be able, while going around the curve, to light his pipe from the engine-driver's fire. Some of the Australian curves are sharp enough, however, occasionally to give the passengers the sensation of a real sea voyage.

Later on, when some views are shown of the country through which the lines pass, a better idea will be given of the work needed to construct them.

BREAK OF GAUGE.

When the first line of railway was authorised in New South Wales, the Colonial Office, which at that time was under Mr. Gladstone's control, sent out a despatch urging the adoption of the 4ft. 8½in. gauge; but the engineer was strongly in favour of a 5ft. 3in. gauge, and it was started on that basis. Victoria and South Australia also started on that gauge. There was a change of engineer in New South Wales before much work was done, and the new man reverted to the original suggestion of 4ft. 8½in., and all the railways in New South Wales have been constructed on that gauge, while all Victorian lines are 5ft. 3in. gauge. South Australian lines are partly 5ft. 3in. and partly 3ft. 6in. All the lines in Queensland, Western Australia, and Tasmania are 3ft. 6in., while the lines taken over by the Commonwealth from the South Australian Government are also 3ft. 6in. gauge, so at the present time Australia unfortunately has three different gauges—3,760 miles, 4ft. 8½in.; 4,151 miles, 5ft. 3in.; and 8,815 miles, 3ft. 6in. gauge.

The question of adopting a uniform gauge has been discussed for years, and the inconvenience and annoyance to travellers under the present system are frequently mentioned, and generally magnified. There is not much, however, to complain about, for you can travel from Longreach, in Queensland, to Oodnadatta, in South Australia, a distance of 3,300 miles, passing through Brisbane, Sydney, Melbourne, and Adelaide, the four principal cities of Australia, and you need only change on account of the break of gauge three times, first on the border of New South Wales and Queensland; second, at Albury, between New South Wales and Victoria; and third, at Terowie, 150 miles north of Adelaide.

The great bar to the adoption of a uniform gauge is the heavy expense in the alteration of the roadway and in the rolling-stock. The cheapest system to adopt would be the 3ft. 6in., but that is not likely to take place. The next least in expense would be the 4ft. 8½in., as all the roadway of the 5ft. 3in. would answer by moving the rails, and many of the cuttings and tunnels even on the 3ft. 6in. would be wide enough for the 4ft. 8½in. line. I notice, by recent reports, that the Commonwealth Government have decided upon this gauge for the transcontinental line from Port Augusta to Kalgoorlie. This will mean a break of gauge at each end of the line, unless South and West Australia alter their gauges accordingly, which is not likely for some years to come.

LINES OWNED BY THE COMMONWEALTH.

By the transfer of the Northern Territory from the South Australian Government to the Commonwealth the Federal Government have become the owners of two railways, one from Port Augusta to Oodnadatta, a distance of 478 miles, and the other from Port Darwin to Pine Creek, 145 miles; both lines are on the 3ft. 6in. gauge.

These lines, 623 miles in all, have cost £3,420,000, or about £5,500 per mile.

The general understanding on which the Northern Territory was transferred to the Commonwealth was that the Federal Government should construct two transcontinental railways, one connecting West Australia with the east by constructing a line 1,050 miles long from Kalgoorlie to Port Augusta, the other to connect the Northern Territory with the south by building a line about the same length from Pine Creek to some point on the Port Augusta line.

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The route of the first of these lines from east to west has been agreed upon, the survey made, and work is soon to commence. Unfortunately, there appears to be some misunderstanding over the proposed route for the Northern Territory line.

It was generally understood, when the Territory was transferred, that this proposed line would run from Pine Creek in the north to Oodnadatta in the south, to connect with the South Australian lines. Some different opinions were expressed about the interpretation of the agreement, but both Governments at the time said there was no necessity for doubt. It now seems as if there was great reason for the doubts expressed, for, judging by the recent reports from Australia, the present Prime Minister, Mr. Fisher, seems more favourably inclined to connect the Pine Creek Railway with the Queensland lines than he is to take the direct and generally understood route straight across the continent from north to south; and it is questionable whether any assurance will be given to the South Australian Government in reference to the matter for some time, especially as there is a general election for the Commonwealth Parliament within twelve months.

If the line is carried to the east, as suggested, and the centre of Australia is left without a railway, the people of South Australia will deeply regret that clearly-defined conditions were not insisted upon before the Territory was transferred.

The estimated cost of the construction of these two transcontinental lines is between four and five million pounds each, or, roughly speaking, about £9,000,000; this, added to the $3\frac{1}{2}$ million liability on the lines already taken over by the Commonwealth, will amount to £12,500,000.

From purely a railway point of view, it is not likely that these lines would prove, for some years to come, payable undertakings. There are, however, two strong reasons for the work.

In the first place, all military authorities for years have urged the necessity of these lines for defence purposes, more especially the line to connect Port Darwin with the south, thus affording the opportunity of direct communication with a naval base in the north, where it would be most likely to be needed in time of attack.

The second strong reason more particularly for the north to south line is that the Commonwealth, having taken over the Northern Territory, have on their hands 335 million acres of practically undeveloped and unoccupied land, nearly four and a half times as much as the United Kingdom with its population of forty-five million, while this vast territory is populated by about 1,000 whites, less than 2,000 Chinese, and a few thousand aborigines.

This vast tract of land can only be properly settled and developed by opening up means of ready communication and transport, and Australia is now realising this fact more clearly than it did years ago; and those who have watched the aggressive progress of the Eastern countries, with their overcrowded millions, must see the necessity for speedy development and settlement in Australia.

Australia's Prosperity.

The great prosperity of Australia during the last few years has given a decided impetus to railway construction, and to-day there are more miles of railway in course of construction, and projected, than at any previous time in its history. Many of these lines, in Queensland, Western Australia, and South Australia, are being cheaply constructed as feeders to main lines, and to open up the pastoral and agricultural lands.

It is well to note here that by the use of artificial manures and more scientific farming, millions of acres are now being settled as agricultural land which a few years ago were only considered fit for pastoral purposes, and some of them but of little value even for pasture.

Private Railways.

In addition to the Government railways, there are about 1,200 miles of private-owned lines in Australia, about half of which are used for passenger as well as goods traffic, while the other 600 miles are used chiefly for carrying minerals and timber. The capital cost of these lines is between three and four million pounds.

Tramways.

The electric tramways of New South Wales belong to the Government, and in South Australia the Government principally control them in conjunction with the municipal authorities.

In the other States the tramways belong to private companies, but will eventually become the property of the corporations. Melbourne has the cable tramway system, and, owing to its expense in construction, it has not extended to the surrounding suburbs to the same extent as the suburban railways have, which the Victorian Government now propose to electrify.

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State Ownership.

There has always been a division of opinion in reference to the advisability or otherwise of State-owned railways. While, generally speaking, Australians themselves are in favour of the system, there are still some exceptions, who think it would have been better to have kept to private enterprise.

From many years' experience in Australia, and from an intimate acquaintance with the working of the railways in one of the States, and a general knowledge of the others, my opinion is that, taking into consideration that the Governments were the owners of the land principally to be developed and settled, and that the settlement could not be effectually carried out without means of transit, the interest of the public has been best studied and preserved by the State-owned system.

Difficulties and Dangers.

It must not be considered, however, that there are no difficulties or dangers in connection with State-owned railways.

Before the appointment of Railway Commissioners in the different States, the political danger was an apparent one, for even Australian politicians in years gone by were not proof against advocating the construction of certain lines when earnestly pressed by interested constituents, especially where majorities at election times were small; and members for districts in which there were large numbers of railway electors may in some unguarded or over-anxious moments have made promises which to fulfil might not have been beneficial to the State. By placing the construction and control of the railways under Commissioners with extensive powers, these dangers have, to a certain extent, been obviated.

There is also the danger of strikes, and, although not as likely on the Government lines as on private ones, there is no absolute certainty that they might not take place.

Some years ago, in one of the States, the President of the Railway Association, who was not a railway man, but a member of Parliament, lent such encouragement to the men's claims—claims that could not be granted by the Government—that a strike was threatened, and had it not been for the good advice of other members and some of the leading railway officials themselves, trouble might have occurred. Since then, in 1903, as is well known, there was a railway strike in Victoria which was of a somewhat serious character. This strike was brought about by over-zealous leaders of the employees against the advice given them by some of the more responsible and cautious men. The result was most unsatisfactory so far as the men were concerned, for instead of their gaining the sympathy of the public, as they anticipated, the inconvenience and disorganisation caused by the strike turned the sympathy to the Government and against the strikers, and in the end the men found, to their sorrow, that there was no good result to themselves, but for some of them loss and disappointment. Since that time there have been no railway strikes except in connection with the tramways in Sydney, Brisbane, and Perth, and in all cases the result has been unfavourable to the strikers.

A statement that is often made against the Government system is that you do not get the best and most able men, and that employees are not as industrious as on private works. But little reliance can be put on these statements, for it stands to reason that Governments can afford to secure the very best men to manage their works just as well as the private companies can. In fact, many of the Railway Commissioners, as well as the engineers and general traffic managers, have been selected from the leading officials of private companies, and some of the private companies have been glad to avail themselves of the services of men who have gained extra experience in Australia. One prominent case of this kind was the late Mr. Matheson, manager of the Midland Company, and Sir Thomas Tait, late Commissioner of Railways in Victoria, is reported to have been offered a very important position in one of the leading railway companies of Canada.

Travelling accommodation and fares for passengers, and freight rates for goods, compare favourably with the railways even in older and more thickly settled countries. In fact, the freight charges on agricultural, pastoral, and mineral products are in many cases exceptionally low, in order to encourage settlement and development.

A Word in Conclusion.

The Government ownership of railways in Australia is often used as an argument by advocates of a national system in Great Britain. This is a matter, however, that does not come within the scope of this paper further than to add that the conditions of the two countries, and the circumstances under which the railways have been constructed, are so different that the greatest consideration should be given to such an important proposal. The result of nationalisation might be the exact opposite

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to that expected by some of its warmest advocates.

If the nation as a whole is to benefit, it might mean a great reduction in the number of employees and much inconvenience to traders and residents in certain localities; on the other hand, if the employees and trading public are to benefit by the change, it might result in a heavy national loss.

DISCUSSION.

The Chairman (Lord Emmott), in opening the discussion, said that the paper, so far from being dry and uninteresting, as the author had led them to suppose it might be, had been one of great interest. Particulars had been given of a vast continent with a great undeveloped tract of territory; and to those present who might be anxious about the food supplies of the future it was quite clear that there was ample territory in the continent of Australia to grow a great deal of the food that would be required. He thought the author had made out his case with regard to the indebtedness of Australia, because when it was seen that two-thirds of the total debt was for railways, which were themselves so highly remunerative, then the amount of the debt became of much less importance. He believed he was correct in saying that something like 85 per cent. of the money borrowed by Australia was for purposes which were absolutely necessary and nearly all directly remunerative. With regard to the question of the State construction of railways, he thought any newly-developed country would be very unwise to allow its railways to be built by private enterprise, and Australia had done very wisely in building State railways. The author's figures proved that, over and above working expenses and interest on capital, there was a net profit per annum on the Australian railways of £4,200,000. In the future, when Australia was much more thickly populated than it was at the present time, the benefit would be greater still, because under the conditions of a largely populated country it became much more expensive to buy out the railways, whereas if the State owned them from the beginning it had a much greater advantage. He was sorry there were so many different gauges of railways in Australia, because in spite of the fact that travellers had to change only three times on one particular route in 3,000 miles, it would be very much more satisfactory if they did not have to change at all. He quite understood that when a railway was built through a very sparsely populated country there was a great temptation to build it on a 3 ft. 6 in. gauge, and to construct it as cheaply as possible. He could quite understand the temptation to build the North and South Railway on the narrow gauge from the point of view of expense, but whether that would be a wise thing to do having regard to the future was another question. The author had said a good deal about the Railway Commissioners, and those present knew enough of what local demands were in regard to railway questions to recognise that it was wise that the control of the railways should not be too directly amenable to political considerations. At the end of his paper the author struck a note of warning when he said it was quite possible that the conditions applicable to Australia were very different from those which obtained in this country. Although it was right that Australia should own her railways, it did not follow that it would be a prudent or wise step in this country to buy out the present owners of railways and for the State to work them. That opened up a very large question which was of particular interest at the present time, because probably all present had read the account in the morning papers of an interview with the Prime Minister in regard to that very matter. There were many obvious advantages in the State-ownership of railways, but under present conditions of finance the financial problem would be a very serious one. He did not agree with those who thought that the financial problem was materially affected by the amount of "water" in the railway stock; the real problem was what would have to be paid for the railways. The price of railway stock was comparatively high at the present time, having regard to the dividend that it earned. The question had to be considered whether, after buying the railways, satisfactory savings could be made by eliminating competition, which would make the whole transaction a profitable one. That opened up a very large question, on which most people at present were very imperfectly informed. With reference to the other great difficulty that arose—the question of labour—the vast continent of Australia was good enough to conduct experiments in labour questions which were of very great interest and value to people in the old country. Nevertheless, Australia had had labour difficulties to meet, and might have further difficulties in the future. No doubt labour difficulties could, and in the course of time would, be got rid of, but if that object was to be achieved a basis must be arrived at under which wages could be fixed at a level which was satisfactory both to the employer and to the employed, and so far an ideal system for achieving that result had not been arrived at. At the present time they were very far from arriving at such a stage, and that was one of the difficulties which bulked very largely in many people's minds with regard to the question of whether it would be wise in this country for the State to assume the ownership of the railways. Personally, he did not consider that the difficulty of finding men fit to manage the railways was so serious as some people imagined. On that point he agreed very much with the author. He had had some opportunity of seeing the men in our great Civil Service, many of whom were men of very extraordinary ability. There was no more reason why men of extraordinary business ability should not be obtained, if they were wanted and people could afford to pay for them, than there was why civil servants of extraordinary ability should not be obtained at

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the present time to do the work they had to do. That difficulty did not bulk largely in his mind, but labour and finance were great difficulties. While he did not think we were likely, in this country at any rate, for the next few years to adopt the principle of State-ownership of railways, at the same time he was satisfied that in a country like Australia they were very wise to do so.

[LORD EMMOTT then vacated the chair in order to keep another engagement, and the chair was taken for the remainder of the meeting by COLONEL SIR THOMAS H. HOLDICH, K.C.M.G., K.C.I.E., C.B., D.Sc.]

MAJOR SIR THOMAS BILBE ROBINSON (Agent-General for Queensland) said that very few people who had not travelled in Australia realised the enormous distances which had to be covered by produce on the way to market, to the coast, or to the stores up country. A lantern slide had been shown comparing the size of Australia and that of Europe. He had surprised many people by telling them what was actually the fact, that the four States comprising British South Africa could be put into the space occupied by Queensland alone, and there would still be 200,000 square miles of territory uncovered. When it was borne in mind that a large proportion of the Australian Continent was still very much in a condition of nature, and that the means of travel where railways did not exist were the bullock waggon and the horse team, it would be appreciated how essential it was that the extension of railways should be proceeded with as fast as possible. It would be readily understood that when the advantages of railways were so great as they were in new countries, a great deal of pressure was brought to bear upon Parliament for further construction before the trade of the districts would, as a commercial undertaking, justify the expenditure. Queensland adopted a method some years ago which had been very effective in checking the demand for what would have been unprofitable railways. Before any new line of railway was made an estimate of the cost and the possible traffic was prepared. That estimate was laid upon the table in Parliament, and automatically, by the operation of an Act which had now been in force for some years, when a railway was made through a district the inhabitants of the district served by the railway were liable to the Government to the extent of 3 per cent. upon the cost of the railway if it should prove unprofitable. It would be very unfair to impose that expenditure upon the taxpayers in the area concerned unless they had the opportunity of saying whether they wished the railway made under those conditions or not. Consequently a local referendum was taken, and if there was a two-thirds majority against the railway the project was vetoed. When the railway had for three years in succession paid 3 per cent. to the Government, the inhabitants in the district were released from their undertaking, because the experience of the Government showed that when a railway had paid for three years in succession a net revenue of 3 per cent. they might with safety take it over and regard it as part of the Government railway, for the successful working of which the Government of the country was responsible. The progress made in the construction of railways was much the same in all the States, but in Queensland, with which he was better acquainted than any of the other States, when the present Commissioner of Railways entered the service of the Railway Department Queensland possessed 21 miles of railway, whereas at the present time it owned over 4,000 miles, and 2,000 further miles were under construction. That expansion, which had occurred within the business experience of one man, showed the extent to which railway development in Australia was being pushed on all sides. A good deal had been said about the question of the difference in gauge. Personally, he did not think that was a matter of so much importance as it might appear to be to one who was not so well acquainted with local circumstances. It was regrettable that there were breaks of gauge between the capitals, but in India there were four different railway gauges, and very little was heard about that. Queensland had adopted the 3 ft. 6 in. gauge, and the railways in that State, although double the length of those in New South Wales, had only cost about half the amount spent by the adjoining State. In a new country, with comparatively few inhabitants, the cost of making the railways, and the necessity for making them as long as possible, went, in his judgment, a long way to justify the selection of the narrower gauge. For all practical purposes the people of Queensland were well content with the 3 ft. 6 in. gauge. It was true the express trains were not run at anything like seventy or eighty miles an hour, but a speed of forty miles an hour could be safely maintained. The practice of the British railways had not been followed of keeping the structure of carriages almost entirely between the two wheels. It had been found from experience that the carriages could overhang on each side, to a certain extent, with perfect safety, and the sleeping carriages now in use on the Queensland railways were, as a matter of fact, three inches wider than the sleeping cars running between London and Edinburgh. The railway stations and tunnels were in some cases wide enough to permit of the laying down of the broader gauge; in fact, the Premier of Queensland, at a recent conference with the Premiers of the other States, offered, so far as Queensland was concerned, to make the New South Wales gauge continuous from Sydney to Brisbane. That would necessitate a third rail being laid from Brisbane to the border, and in order to make the junction with the existing service New South Wales would require to extend her railways by about twenty-eight miles. The project was so near adoption, that he thought within a very short time it would be found that at any rate one of the breaks of gauge as between the capitals had been avoided, and that

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the New South Wales gauge would be found running right up to Brisbane.

MR. HERBERT W. ELY (Secretary, Tasmanian Government Office) said that Australia possessed the finest climate in the world and resources of the greatest productive possibilities, but those assets would have been useless without a progressive railway policy. The author had pointed out that the Tasmanian railways did not actually pay, but there were sure signs that in the comparatively near future they would do so. The Government had embarked on a progressive construction policy all over the island. Great mineral developments were proceeding on the west coast; mines that had been lying dormant for want of smelters had started, and the smelting works were going full blast; and new mining fields were rapidly being opened up. A new process works was being put up at Rosebery in the centre of the west coast district to deal with the refractory sulphide ores which had been lying untouched to the present day because it had been impossible hitherto successfully to treat them. All that meant that large areas of western Tasmania would be developed, with the result that the whole of the railway system in that part would become a paying proposition, so that the reproach that Tasmanian railways did not pay would be removed in the near future. The author had touched very diplomatically on the question of State-owned railways. He thought everybody was agreed that in a new country like Australia it was impossible for railways to be owned privately without a large concession being granted, and without sooner or later coming into conflict with the developmental policy of the Government of the country. For that reason it was most advisable, where the main railway system existed, that the whole of the railway system should be in the hands of one authority. Another point was that only a Government could afford to build a railway and to run the risk of it being run for the first few years at a loss. That had frequently happened, because the railways must be pushed forward into new country in order that settlers might follow the railway and develop the land. It was quite impossible to expect a settlement in a new country where the people had to send their produce perhaps hundreds of miles by road, not to speak of the appalling isolation with which they were confronted; so that unless a private company had some recompense in a large land concession, the work must be undertaken by the Government.

MR. H. S. GULLETT thought the most attractive part of the paper was where the author made the statement that railways were now being built in Australia at a rate considerably faster than had been known in the past. The rate at which Australia was building railways had a very important bearing upon the immigration question, and the present railway policy was one of the best assurances that could be given to the British people that Australia was taking all possible steps to make room for large numbers of British emigrants. The immigration figures in recent years had been very remarkable. In the ten years between 1895 and 1905 Australia made a net gain by immigration of only about 500 people a year. Between 1905 and 1908 the rate of gain was increased to some 17,000 a year; in 1909 there was a gain of 29,000; in 1910, 37,000; and last year between 70,000 and 80,000. Most of the people were adults who were going on the land. If the wonderful example of Canada was followed, it might safely be predicted that in five or six years' time about a quarter of a million people a year would be taken into Australia, if sufficient boats could be obtained to carry them. The new railways were of great importance, because they increased the settlement upon the farming country, and they were also making much safer the pastoral settlement. Large sums of British money were invested in Australia in pastoral production, and in the low rainfall districts the trouble in dry seasons was chiefly due to the fact that the stock could not be moved about as readily as was desirable. Australia very rarely had a general dry season, and if it was able by means of railway systems to transport the stock quickly from one portion of the country to another, they practically insured the whole of the pastoral country against trouble in time of drought. That he thought was one of the most important features, from a national standpoint, of railway construction in Australia at the present time. By means of the new big transcontinental line, Australia was linking up the east, where most of the people were to-day, with the lightly populated west and north, and so bringing Australia closer to Europe. It was very interesting at a time when the building of a railway was being considered right down through Europe and Asia to Bombay, that the question of the construction of the transcontinental line across Australia was under consideration. If the trans-Asia railway were constructed London would be only seven or eight days from Bombay; Bombay was within nine days' steaming of Australia—and that time could be very much shortened—so that it was quite possible that in twenty years' time England would be within fourteen or fifteen days of the eastern States of the Australian Commonwealth.

MR. H. C. ALLEN (Buenos Ayres Great Southern Railway Company) said that railway men in the Argentine Republic naturally took a very great interest in railways in all parts of the world. Of the 20,000 miles of railways in the Argentine Republic, 80 per cent. were owned and worked by private English companies. The Government, however, owned some of the railways, which they had constructed, he thought, in very suitable parts of the country, inasmuch as the districts through which they ran were difficult to develop by means of private enterprise, because the railways were not likely to pay for a long time. Three different gauges of railway existed—the Indian gauge of

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5 ft. 6 in., which was the original gauge in Argentina; the 4 ft. 8½ in.; and the narrow metre gauge. He could bear out the remarks a previous speaker had made with regard to the advantages of narrow-gauge railways in certain parts of the world, more particularly where the first cost was a question of great importance. The overhang indulged in by the railways in Argentina had enabled many of the narrow-gauge lines to have almost as wide carriages and waggons as some of the 5 ft. 6 in. lines, because the width of the rolling-stock of the latter was regulated by the existing stations, bridges, etc. To increase the overhang of the carriages and waggons under such conditions, in order to get the full benefits that the width of the gauge might give, would be an exceedingly expensive matter. It was a common thing on a metre-gauge line to have 30-ton waggons and luxurious sleeping and dining-cars and other conveniences similar to those provided on the 4 ft. 8½ in. railways at home.

Mr. W. P. Durtnall, speaking as an engineer, thought it was extremely desirable that the possibilities of the internal-combustion engine for use on Colonial railways should be thoroughly investigated before an enormous expenditure was incurred in the provision of steam-operated trains. There was also the possibility of the combination of high speed internal-combustion engines with electrical apparatus, a self-contained locomotive thus being obtained. It had been proved, he understood, that for 1 ton of oil costing 40*s*., a train of 300 tons could be driven four or five times farther at the same price than a train drawn by a steam engine.

The Chairman (Colonel Sir Thomas H. Holdich) said that unfortunately his travels had never taken him to Australia, and he was, therefore, entirely ignorant of the country, and his public services had never in any way been connected with railways. But as he had lived for many years in India he wished to draw attention to the fact that it was always exceedingly dangerous to accept the analogy of one country in matters of railway construction or railway policy as a guide for another. He regarded Australia as a trebly blessed country. It had no North-Western Frontier with a perpetual recurrence of North-West Frontier wars; famine was practically unknown in the country; and there was nothing in the shape of a deadly pestilence to contend with; all of which were well known to the Government of India, and had interfered from time to time with the development of railways under State control that would have taken place had Government been free from those troubles and difficulties. It was the fact that Australia, with its comparatively small population of four millions, had rather more than half the length of railways which India possessed with a population of something like 300 millions; and yet it would be very difficult to say that railway construction in India could be pushed ahead, either under State control or by private enterprise, to any very considerable extent faster than it was now. Although he thought State regulations with regard to construction might very well be modified so as to make it easier for private enterprise to undertake a greater extension of railways than was the case at present, nevertheless in a country like India, where financial support was dependent on such causes as he had just mentioned, it was impossible to expect any very large and decided increase to the great system of railways in that peninsula such as might be expected in such countries as Australia or Tasmania.

The Hon. J. G. Jenkins, in reply, said the remarks made by the various speakers had been so complimentary that there was hardly anything to reply to. With reference to Mr. Durtnall's remarks, he noticed from a cablegram received about a week ago that the Minister for Home Affairs of the Commonwealth Government, who was specially interested in the construction of the proposed railways, had stated he was making every investigation into the possibility of utilising petrol-power instead of ordinary steam-power, so as to save the expenditure of, he believed, nearly half a million pounds in the construction of waterworks along one of the routes. That statement was probably authentic, but whether the report meant that the Commonwealth Government were going to adopt the system he could not say. He knew, however, that the Government would not be blind to the possibility of saving money by adopting any new system, if it was practicable for the purpose.

On the motion of Mr. Byron Brenan, C.M.G., seconded by Mr. Harry E. Brittain, a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

THE PHOSPHATE INDUSTRY IN ALGERIA.

The most important deposits of mineral phosphates in Algeria are to be found in the Department of Constantine, and more particularly in the neighbourhood of Tebessa, close to the Tunisean border. Amongst the principal beds of phosphate of lime, those at Ain-Kissa and Dibba, situated about five miles from Tebessa, worked by a French company, are of considerable importance. Another company operating near the village of Bordj-R'dir have an output of about 20,000 tons annually, which, by means of an aerial cable 10½ miles in length, is carried to the railway station at El-Anaced, and from thence to the port of Bougie for shipment. There are also important beds of this substance at Dyra-Nord, about thirteen miles to the north-west of Tebessa, yielding 65 to 70 per cent. of phosphates.

Amongst the most important deposits of phosphates in the colony may be mentioned those at Djebel-Kouif situated to the north-east of Tebessa, which are exploited by an English company. The substance when first excavated is grey in colour,

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which rapidly turns white when exposed to the air; it yields 58 to 60 per cent. of phosphate. The mines are connected with the railway to Bona, where it is shipped.

The deposits at Tocqueville, worked by an Algerian company in the western part of the Department, are situated about twenty-four miles from the station at Setif on the railway from Algers to Constantine, to which they are connected at Tixter by a narrow-gauge line about eight miles in length. The mineral, which contains 58 to 60 per cent. of phosphates, is shipped at Bougie.

The exports of the natural phosphate of lime from Algeria have increased nearly three-fold during the last ten years, as will be seen as follows:—

	Exports.		Total Exports.	
	To France. Metric tons.	To other Countries. Metric tons.	Metric tons.	English tons.
1902	46,815	81,581	128,396	126,374
1903	72,049	276,027	348,076	342,594
1904	87,524	279,810	367,334	361,549

ARTS AND CRAFTS.

Home Arts and Industries.—The Twenty-eighth Annual Exhibition of the Home Arts and Industries Association, which was held at the Albert Hall in the middle of May, was a more than usually interesting event. The Association has done yeoman service for many years in helping forward the movement for the revival of artistic handicrafts, and its shows have always been well worth a visit; the time has now come when they represent not only aspirations but also a good deal of real accomplishment. Some of the Developed Industries, it is true, seem to the outside observer to have passed the stage when their connection with the Association is altogether incomprehensible; but leaving these exhibits out of account, the work turned out by the Partially Developed Industries and the Home Art Classes, is not only creditable to those concerned in its production, but interesting and attractive in itself, quite apart from sentimental considerations as to how and by whom it was carried out. Very little of the rather showy work, grand enough in conception but lamentably poor in execution, which seemed to threaten to predominate a few years ago, was to be seen this year. Some work there was, indeed, large in scale and ambitious in aim, but in most cases the ambition was justified by the power to carry it through successfully; moreover, the number of exhibits of this type was not very considerable. The bulk of the exhibition was made up of modest and tasteful work, quite pleasing in design, and executed with a very reasonable amount of technical skill. The objects on view did not call aloud for notice, but when they were carefully looked at they were generally very satisfactory both in design and workmanship, and would have more than held their own had they been shown with works produced under different conditions. When one remembers the kind of exhibits which were in the majority at the exhibitions held some ten or fifteen years ago, to go no further back, one realises how much the Association has done to foster and direct home industries in this country. People are ready enough when they travel on the Continent to grow enthusiastic over, and to patronise, the peasant industries which they find there—is that, perhaps, in part due to the fact that their products can be purchased so very cheaply?—but they are apt to forget that even in England we have peasant industries which are by no means to be ignored.

Since a great many of the workers connected with the Home Arts and Industries Association are women, it is only natural that embroidery, lace-making, and weaving should be amongst the crafts most largely represented at the Albert Hall. Some of the drawn-thread work, notably that from Langdale, was very good, and the workers are beginning to appreciate the value of colour introduced in work of this kind. The samplers from Milford were on the whole very dainty, and extraordinarily satisfactory in colour, whilst the embroidery and weaving from Windermere was, as one has grown to expect, characterised by a strong appreciation of the value of colour. The lace from East Devon was, much of it, remarkably accomplished work, and there was good work sent from Diss, Buckinghamshire, and other places. Rugs have come to be quite an important class of exhibits, and many of them were very good in colour. Some of the lacquered leather was rather aggressive, but the leatherwork shown by Leighton Buzzard, and the work of other, less advanced, classes, was generally well executed and pleasing in tone. The carving as a whole was a good deal better than usual. The exhibits from Ascott were really remarkably satisfactory, and many of the less ambitious classes sent very good examples of chip carving, and simple work in low relief. The metal-work from Yattendon was well-made and attractive, and the pottery from Compton was not wanting in the peculiar charm which one associates with it.

The Book Exhibition at the Central School of Arts and Crafts.—The exhibition of the work done in the London County Council trade-schools connected with book production, which was held at the Central School of Arts and Crafts during the latter part of May, showed very clearly how much is being done for the artistic and technical training of bookbinders and printers. The account of the history of the Council's classes in book production, published in the catalogue, shows, amongst other things, how a scheme of training in printing and bookbinding has been established, which ought to help boys to a better practical and theoretical knowledge of their trade, without unduly delaying their apprenticeship. The trouble with the technical schools in the past has been that boys trained

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in them naturally do not want at the end of their school days to start in their trades on the same level as boys who have just left an ordinary elementary school, whilst the masters are a little afraid of employing them on any other footing than that of beginners. The plan of allowing boys to enter the trade-school at thirteen years of age, and of apprenticing them while they are still there, seems to point the way to a solution of the difficulty. The specimens of typesetting—titlepages, notices and displayed work generally, as well as simpler work—made it very evident that the students in this department of work are being trained to produce tasteful pages, far better spaced and arranged than the ordinary run of trade productions. Some of the examples shown were really excellent, and the work as a whole was on good lines and tending altogether in the right direction. It makes one hope that in the near future, not only bookwork but advertisements may be more artistically planned than is at present the case, although they are already far better than they were some years ago. The writing and illuminating shown was good and rather more catholic than usual, one or two specimens being written in a quite pretty and comparatively modern type of hand; but in spite of the fact, called attention to in the catalogue, of a German fount of type having been inspired by the English revival in pen-made lettering, a good deal of the work done in this section, beautiful as it is, seems somewhat remote from practical present-day needs. The bookbinding, again, does not give one any idea of the possibility of a tasteful book-cover which is within the purchasing power of any but the rich. This is, doubtless, as it should be from one point of view, since our ordinary cloth-cased books are not bound at all in the stricter sense of the word—but one looks in vain for any designs for cloth casings or suggestions as to their colouring. There were a large number of leather-covered books on view, and they were well bound and very often tastefully ornamented. A certain tendency to over-enrichment was probably due to the students' desire to do all they knew and to do as much tooling as possible on one volume. The work as a whole reached a very high level, and gave evidence not only of good workmanship, but in some cases of a real power of planning and designing simple and effective tooled covers.

Two Bond Street Exhibitions.—Two exhibitions have been held in Bond Street during the past month which are worth recording from the point of view of Arts and Crafts. At the Doré Gallery, Baron Arild Rosenkranz has been showing a large four-light memorial window, together with a smaller window and a little panel of stained glass. The memorial window consists of four full-length figures (labelled—not in pre-eminently satisfactory letters—as Fortitude, Faith, Truth and Justice) very skilfully framed by a vine with a thick purple-brown stem and clusters of white fruit. The general effect of the figures is blue-green and the flesh is decidedly greenish in tone, but a certain amount of purple is introduced in the draperies in such a way as to keep the general colour-effect from being in any way sickly—while the pearly, almost semi-opaque, glass of which the background is composed, fits in peculiarly well with the general colour-scheme and gives a certain homogeneousness to the window, which would have been lacking had the ground been leaded up in clear glass or been formed of painted quarries. Baron Rosenkranz evidently understands very well the importance of using good glass in his windows. It looks as though, in this instance at any rate, he had chosen every piece to fit its own particular place in his composition, and the result has amply rewarded his pains. The colour of the small baptistery window is not so satisfactory, but that may be due in part to the conditions under which it is shown; and the artist certainly proves in his small panel of bright red birds flying amidst vivid green leafage that he can manage strong pot-metal colours very successfully. The little exhibition was a striking proof of the importance of the artist keeping in touch with his window after it has passed the cartoon stage. In dealing with stained glass it is not enough to indicate that a certain piece of drapery is to be green, or even of a particular shade of green, if one wishes to get the best effect out of a material which displays the infinite variety to be found in a single piece of pot-metal glass. What is necessary is that the artist shall personally supervise the window and have something to do with the choice of the glass actually employed.

At the St. George's Gallery, the Misses Violet and Frances Ramsay have been showing some jewellery which is quite worthy of their reputation. Among the many women jewellers of the present day, there are perhaps some who turn out daintier and more lightly pretty work, but there are none who have more feeling for style or a better sense of proportion, and of how to introduce their stones in the most satisfactory way. Miss Dora-Brooke Clarke's work, which was shown at the same time, though by no means poor, was not able to hold its own in the company in which it found itself.

CORRESPONDENCE.

THE ETYMOLOGY OF NAILBURN.

The discussion raised by the Rev. W. Blissard, of Bishopsbourne Rectory, Canterbury, on the etymology of the term nailburn, as applied to the intermittently flowing brooks of Kent, is of wide interest, and should find a record in our *Journal*. He himself, writing in the *Times* of the 13th May, suggested that the word was a corruption of "helburn," or "elburn," meaning a "heled," that is, a concealed burn or brook: as in the case of Helwell, meaning "the Covered well," in

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Devonshire. In the *Times* of the 15th May, Professor Skeat,—an authentic miracle of philological science, and etymological scholarship, and the pure shining light of contemporary English lexicography,—quoting from Birch's "Anglo-Saxon Charters" the forms "Naeglesburnan," which he renders Nailsburn, and "Nælesbroc" as Nailsbrook, and "Neglescumb" as Nailscombe, and "Nægleslеah" as Nailsley, observes that it would appear as if Naegel [Nail] could be used as a personal name; and immediately continues: "There is an interesting article on Nagel in Schmeller's 'Bavarian Dictionary,' in which he reminds us that it was the name of the peg used in the peg-tankard, and was even used to express a definite quantity of liquor [compare 'brandy pegs' of Anglo-Indians] . . . I am unable to say if there ever was a hobgoblin called Nael . . . but I think I have proved clearly enough that the English word ought to begin with [a capital] N." Beyond that Professor Skeat does not dare.

Only Ulysses may bend Ulysses' bow; but, failing some "goblin dam'd," or "Saint" Nigel [= "Nigger"], I must "make bold to say"—as people say in Devonshire—that I still hold by the Rev. W. Blissard's solution of the problem, although for other reasons than those advanced by him. It is quite true that in Devonshire "to hele" everywhere means "to roof" a house, and, in particular, with "heling stones" or slates; and also to tump-tump potatoes, celery, etc.; and throughout "Wessex" "hellier" means a slater, a tiler, and a thatcher [whence such surnames as Hillier, Hellyar, Tyler, Tylor, Thuillier, etc.]; while "hele," in the form of "eel," means, all along the March of Wales, "to cover" generally. But there is another "hele," or "hell," in provincial English, meaning, in Wiltshire, "to pour out," and in Yorkshire, in the form of "hellered," "a river in flood"; and elsewhere, in the form of "hellek," any "small stream." Accepting, therefore, in default of an eponymous hobgoblin, or saint, the possibility of nailburn being a corruption of "helburn" or "elburn," I would argue that the "hel," or "el," in the term has nothing to do with the periodic calypsis of the "nailburns" of Kent, and that these alternative flections simply mean "burn," or "brook"—in the present instance the burn or brook that gives its name to Elham; and that nailburn here, and elsewhere in Kent, is but a repetitive denomination, meaning "brook-brook," examples of which we have in such tautological place-names as Elbe-river, Wash-burn, Ouse-burn, and Ash-bourne, all meaning "Water-water"; and again, in Romney-marsh, meaning "Marsh-marsh," and in Brai-don-hill, meaning "Hill-hill-hill."

Nail from *nægel*, "a nail," "a pin," "a peg," is to be found in English place-names, and in respect to them is generally referred, I cannot say traced, although I would fain have it so, to "Saint" Nigel. In the Norse form of *naal*, it is found in the name of Nalsöe, one of the Far öes, or "Sheep-islands." The Devonshire "neele" for needle, is the Dutch *naael*. The English surnames Nail, Naile, Nall, refer to ancestral residence "at *an-ale* house"; and of Nailer, Nailor, Nayler, to ancestral occupation of nailers; at least, so the etymologies of these patronyms have been—so far!—"dared, determined, done," by the masters of such familiar mysteries.

If all this still leaves the problem of nailburn unsolved, my reply is, that the liveliest interest in every research lies in its pursuit, and not in its solution. The eccalypsis of our earthly, palaeocrystic Poles, has made the Southern Pole, with its delightful, companionable penguins, as homely as Clapham Common; and the Northern, as familiar as our "Happy" Hampstead Heath of Sundays.

George Birdwood.

INDIAN RAILWAYS.

As Mr. Neville Priestley has completely misunderstood at least one—the first—of my reasons for believing that the 1910 Rebate Terms will prove as unsuccessful as those of 1893 and 1896, I shall be obliged if you will find room for this letter in the next issue of the Society's *Journal*. I will deal with Mr. Priestley's remarks seriatim—

(1) I am quite aware that the Rebate Terms specifically limit the cost of working branch lines to 50 per cent. of the branch line's gross earnings. This proviso is not new, and will be found in the Rebate Terms of 1893 and 1896 as well as in those of 1910. But this has nothing to do with the point raised by me. My reference was to the cost of working traffic *interchanged between the branch and main lines*, not to the cost of working branch-line traffic. The cost of working the first-named traffic has not, so far as I know, been definitely fixed, and by implication the 1910 Rebate Terms show this. If the cost of working this traffic had been definitely fixed at 50 per cent. of the gross earnings, Government would surely have adhered to the principle of the previous Rebate Terms, and have offered a rebate "not exceeding 50 per cent. of the *gross* earnings," and not one "not exceeding the *net* earnings." The presumption is that Government themselves recognise that the *net* earnings may possibly be *less* than 50 per cent. of the gross earnings. In my opinion they will be found to be considerably less.

(2) I never stated that the main lines are not interested in "working up" the traffic of branch lines. Obviously they are interested. What I said was, that where the rebate would be *most* wanted, the main line had no direct interest in keeping the cost of working the interchanged traffic low. In such cases, where the whole of the net earnings of this traffic are absorbed by the branch lines, that is, where the interest of the branch lines calls for low working expenses, the main line has no direct interest whatever in keeping them low. As this traffic then contributes nothing to the main-line revenue, why should that line go out of its way to

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reduce expenses? That the Rebate Terms provide for Government taking over branch lines *before* the expiry of the contract, confirms my statement that the position of branch lines is in many ways unsatisfactory, and that they have no future.

(3) With all respect, I cannot accept as an axiom Mr. Priestley's dictum that it must be assumed that the financial advisers to Government, in all cases, know their own business best, or that they have always good and sufficient reasons for their action. But in the present instance, I am quite prepared to admit that their advice is good, and that Government is wise in following it. It is because I consider that advice good, because I think that Government are wise in not taking upon themselves the risk of constructing branch lines on Rebate Terms, that I believe that investors will be chary in accepting them. J. FORREST BRUNTON.

Mr. Neville Priestley, to whom the foregoing letter has been submitted, writes:—

I am sorry I misunderstood what Mr. Forrest Brunton said, but the reasons he now gives for his views do not, in my opinion, alter the situation in any way. Taking his points seriatim—

(1) He is quite right when he says the Rebate Terms do not limit the cost of working interchanged traffic to 50 per cent. thereof; but they do limit it to the same proportion as the working expenses of the main-line system bear to its gross earnings. That, it is true, is an indefinite figure, but by looking at the past history of the main line it is possible to form some idea of what the cost of working interchanged traffic is likely to be, and consequently what percentage the net earnings are likely to be of the gross earnings from interchanged traffic. Having ascertained this, however, one is no nearer an exact figure, as the amount of the interchanged traffic itself is an unknown quantity and it would not carry one any further in one's knowledge if Government were to lay down that the net earnings from interchanged traffic were to be taken at 50 per cent. of the gross earnings therefrom. Nor could the position be otherwise, because if the amount of rebate could be fixed, it would virtually become a guarantee. A direct guarantee only operates when the income of the line itself fails to cover its interest charges, and that would be the case with the rebate also. It is the indefiniteness of the amount of the rebate that gives the stock its speculative character, and takes it out of the category of guaranteed stock in which trustees may invest and places it in the category of unguaranteed or "ordinary" stock in which trustees may not invest and from which a higher return is, therefore, demanded. Whereas, if the amount of the rebate was fixed, it would become guaranteed stock, and lines promoted under the Terms would fall immediately under the hampering influences of such stock.

(2) The main line cannot control the *cost of working* interchanged traffic, that is to say, make it greater or less because the traffic was important or otherwise, for the simple reason that interchanged traffic is not confined to a particular section of the main line or carried separately from other traffic. But even if the main line could control the cost of working interchanged traffic, it would make no difference, because the cost of working such traffic, so far as it affects rebate, is based on the cost of working the entire system. I cannot see how the fact that the Rebate Terms allow of the acquisition of lines constructed under them before the expiry of the contract is injurious. Stockholders are interested in dividends and in securing their capital. Government undertake to pay back not twenty times, which is what the price at which their stock stands would require, but at twenty-five times the average net earnings. That not only gives the investor all his money back, but a considerable bonus as well. The terms are, therefore, generous and statesmanlike, not mean and pettifogging.

(3) I speak with an inside knowledge of the Government of India, an advantage which I think Mr. Brunton has not had, and I can say very positively that when determining the borrowings for the year, the thought never enters into the minds of the Secretary of State's financial advisers whether a particular line will or will not cover interest charges. Indeed, it is not till after the amount to be borrowed has been decided that the lines which are to be constructed are selected, and the selection—I speak again with inside knowledge—is not influenced by the returns likely to be yielded, but is governed by the importance of the line from a famine or strategical point of view or, when these considerations are not uppermost, by the seductive advocacy of some Governor or other important personage or public body. For the Government deliberately to foist upon a confiding public a scheme which they know to be unsound, would not be clever but excessively stupid, because it would defeat their own object, which is to try to coax private enterprise to undertake the construction of railways in India. I do not think one need go further back than the last loan to realise the difficulties of the India Office in regard to the raising of money. It is to meet that difficulty that the Rebate Terms of 1910 were promulgated, and it was to show what influences are still likely to operate against the attainment of their object by the Government that my paper was written.

NOTES ON BOOKS.

MEN AND MEASURES. By Surgeon Lieut.-Colonel Edward Nicholson, F.I.C., F.C.S. London: Smith, Elder & Co. 7*s.* 6*d.* net.

As the sub-title indicates, this volume is "a history of weights and measures, ancient and modern," an extraordinarily difficult and complicated subject, which the author has spent many years in studying. The importance of securing standard weights and measures is so obvious that

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they may be said to be among the first essentials of civilisation, and no one will be surprised to learn that among the earliest peoples of whom we have any record there were elaborate systems. But one may, perhaps, be surprised to hear on what scientific bases some of these systems were built. "There is not the slightest doubt," says Colonel Nicholson, "that the common cubit of ancient Egypt, brought probably from Chaldaea, was deduced from the measurement of the earth, from the quarter-meridian distance between the pole and the equator. There are no written records of this measurement; but an imperishable monument remained to record it, and other ancient monuments still remain to corroborate this testimony. The base of the Great Pyramid was, from ancient times, always known to be 500 cubits long on each side, and it is found to be exactly half a meridian mile, or 500 Egyptian fathoms, in perimeter. There is no doubt that the wise men of the ancient Eastern kingdoms had great astronomical knowledge, and were capable of making the necessary meridian measurement."

It is not possible, of course, to follow Colonel Nicholson in detail through his history, either of the early scientific systems of weights and measures or of the genesis of what one may call the rule-of-thumb systems, which were based on such measures as the digit, palm, span, etc. Suffice it to say that he gives a careful account of a large number of systems, ancient and modern, occidental and oriental, some of which afford very interesting reading. The variety of systems which have been in use in different parts of this country is extraordinary, and makes one wonder how, with all this complication and confusion, it has been possible to carry on business at all. But in spite of one's preconceived theories, it seems possible that the rough-and-ready systems, which have grown up apparently by chance, may possess practical advantages outweighing the theoretical benefits of a scientifically planned table.

In this connection, Colonel Nicholson's chapter on "How the Metric System works in France"—one of the most interesting chapters in the book—is particularly instructive. He quotes a great many instances to show how, in spite of official pressure, State education, and police proceedings directed to enforce the adoption of the scientific methods, the old-fashioned systems still persist. "Barometers for ship-use have their scales usually in ponces and lignes. The port barometer on the quay of the great naval port of Toulon, in front of the town hall, is on this old scale . . . The sounding-line of French ships is in brasses of five old French feet, the cable is of 120 brasses, the knot is, as with us, $\frac{1}{120}$ of the nautical mile of 1,852 metres, the kilometre being absolutely ignored. . . . Wine is sold wholesale by the queue, by the barrique, by the feuillette. A barrique or piece of Bordeaux wine is 228 litres; of Burgundy 212 litres. . . . The housewife continues to ask for a four-pound loaf, a *pain de quatre livres*, for a *livre* of sugar, for a *demi-livre* of coffee, for *un quart* of chicory, for a *demi-quart*, or for *une once* of pepper. In the market-place, in the streets, fruit is openly cried at *quatre sous la livre!* or *deux sous le quart!* when no policeman is within hearing, and the police are discreetly deaf, even in Paris, except when ordered to be more vigilant . . . In country towns goods are often openly ticketed in sous; I have even seen 'six liards,' six half-farthings, two for three-halfpence, as the marked price . . . The peasant bargains for cattle in écus (half-crowns), or in pistoles of ten francs . . . Land is reckoned in the old measures according to local custom, and tables of these measures, with their metric equivalents, are given in the 'Usages locaux,' published for the use of *juges de paix* and other officials. Farms to let and land for sale are frequently advertised in these local measures. If the extent is given in hectares, the local equivalent in vergées, etorées, etc., is added . . . I ask a farmer, not six miles from Paris, how much land he has, and he, knowing me to be 'safe,' says so many estrées. How much is an estrée? Sixteen hundred square toises is his answer."

Colonel Nicholson multiplies these instances through several pages, but perhaps enough have been quoted to show how exceedingly difficult it is to change the weights and measures of a people, even when you substitute for clumsy and unmanageable tables the most simple systems designed by the greatest of mathematicians, and backed by all the authority of the State.

ARTISTIC LEATHER WORK. By E. Ellin Carter. London: E. & F. N. Spon. 2*s*. 6*d*. net.

Miss Ellin Carter is well known as a specialist in the artistic decoration of leather, particularly in the Mexican style; and, in addition to being a craftswoman herself, she has had considerable experience as a teacher. Consequently she is in a position to know both what the young student wants in a text-book, and to supply it. This little volume is simple and practical. After describing the tools and materials, Miss Carter discusses the different methods of decorating leather, by incising, embossing, modelling, carving, hammering, etc.; and this she follows with useful sections on colouring and staining, padding and making up. Hitherto there does not appear to have been a good elementary manual designed for the use of beginners, and Miss Carter's book should prove useful in encouraging young students to undertake the study of a charming and artistic craft.

GENERAL NOTES.

THE CRICKET-BAT WILLOW.—The Kew *Bulletin* contains an interesting note on the cricket-bat willow. The best of all willows for bat-making is a pyramidal-growing female form of the blue willow (*salix alba* var. *coerulea*) which, except for recent plantings, is only found in a few East Anglian counties. The East Anglian climate is

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the driest and sunniest in the United Kingdom, and doubts existed whether the timber of the cricket-bat willow would retain its peculiar value if it were produced in a warm, humid climate. Large numbers of cricket-bat willows have been planted during the past five years, and it has become important to ascertain how far the labour and expense incurred in districts with such a climate is likely to be recompensed. An encouraging report is made on some timber of cricket-bat willow grown on the estate of Mr. J. Arthur Campbell, at Arduaine, Lochgilphead, Argyllshire, where the rainfall is 60 inches per annum, as compared with that of East Anglia, which is under 25 inches. There appears to be sufficient proof that the peculiar virtues of the willow are inherent and not necessarily dependent on its environment.

Cedar Rails for Pencil Wood.—The demand for cedar-wood for pencils has been so great of late that every possible source of supply has been eagerly sought for. It seems that the early settlers in Tennessee built their houses of cedar logs, which have stood exposure to the elements without suffering much damage. A considerable number of these buildings have been stripped of their cedar, and large quantities of the wood have been shipped to Germany and other countries. A substantial source of supply has also been found in the old fence-rails of cedar which are plentiful in Tennessee. These rails, according to *Timber News*, are a source of great wealth to many farmers; in one case it is stated that they were even of greater value than the farm itself. During the past year, in the Murfreesboro' section alone of the State, the American Pencil Company paid $200,000 for old cedar rails, to be used in the manufacture of pencils.

Servian Textile Industries.—Carpet-weaving is one of the oldest industries in Servia. The product is manufactured principally at Pirot, in south-eastern Servia, and the carpets are named after that place. A large number of women and girls are engaged in this industry, and practically every home in the Pirot district has at least one carpet-loom. The chief characteristics of these carpets are that they are made of pure wool dyed with natural colours by local dyers, who pride themselves that the process of dyeing and colour-mixing is a secret transmitted by father to son, and is known only to the inhabitants of Pirot. The manufacture of articles from hemp and flax is an important home industry. The climatic conditions of southern Servia are so exceptionally favourable for growing hemp and flax that practically the whole village population in that region is engaged in the culture of these two plants, and the industry is of the greatest importance to the welfare of a large number of people. The industry is beginning to pass into the hands of larger manufacturers, and modern factories, producing cordage, etc., have been started in several places.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 10...Geographical, Burlington-gardens, W., 8.30 p.m. Sir William Willcocks, "The Garden of Eden."

Tuesday, June 11...Photographic, 35, Russell-square, W.C., 8 p.m. Mr. F. Martin Duncan, "The Application of Photography to Biological Research."

Colonial, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Dr. Vaughan Cornish, "The Panama Canal and its Relation to the British Empire."

Gas Engineers, at the Royal United Service Institution, Whitehall, S.W., 10.30 a.m. Annual Meeting. 1. Mr. R. G. Shadbolt, Presidential Address. 2. Report of the Refractory Material Research Committee. 3. Report on the Education and Certification of Gas Fitters. 4. Mr. H. Townsend, "The Incidence of the Day Load Factor." 5. Mr. A. W. Onslow, "High-Pressure Gas for Manufacturing Purposes."

Wednesday, June 12...American Women in London, Society of, at the Royal Society of Arts, John-street, Adelphi, W.C., 3 p.m. Mr. de Lisle Burns, "Bergson's Philosophy."

Biblical Archæology, 37, Great Russell-street, W.C., 4.30 p.m.

East India Association, Westminster Palace Hotel, Victoria-street, S.W., 4.30 p.m. Mr. William Durran, "The Defects in the Legal Systems of England, India, and America."

Aeronautical, at the Royal United Service Institution, Whitehall, S.W., 8 p.m. Mr. G. Holt Thomas, "Hydro-Aeroplanes."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Professor M. A. Gerothwohl, "Alfred de Vigny, and his Relation to English Pessimists."

Gas Engineers, at the Royal United Service Institution, Whitehall, S.W., 10.30 a.m. Annual Meeting. 1. Mr. S. Meunier, "The Evolution of Stockport Gas Works." 2. Dr. R. Lessing, "A Laboratory Method for the Comparison of the Coking Properties of Coal."

Thursday, June 13—Antiquaries, Burlington House, W., 8.30 p.m.

Mathematical, 22, Albemarle-street, W., 5.30 p.m.

Gas Engineers, at the Royal United Service Institution, Whitehall, S.W., 10.30 a.m. Annual Meeting. 1. Mr. T. Glover, "Some Observations on the Examinations in Gas Engineering." 2. Mr. J. H. Brearley, "Some Notes on the Examinations in Gas Supply."

Friday, June 14...Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. H. Savage Landor, "Unknown Parts of South America."

Malacological, Burlington House, W., 8 p.m. 1. M. M. Schepman, "On a Collection of Molluscs collected by Mr. E. Jacobson in Java." 2. Dr. J. Cosmo Melvill, "Descriptions of Thirty-three New Species of Gastropoda from the Persian Gulf, Gulf of Oman, and Arabian Sea." 3. Mr. Wm. H. Dall "Note on the Generic Name *Pectunculus*. 4. Mr. Tom Iredale, "Note on *Ianthina* Species.' 5. Mr. Maxwell Smith, "Egyptian Non-Marine Molluscs."

Astronomical, Burlington House, W., 5 p.m.

Geologists' Association, University College, W.C., 8 p.m. Professor Grenville A. J. Cole, "The Geology of West Mayo and Sligo, with special reference to the August Long Excursion."

Physical, Imperial College of Science, South Kensington, S.W., 8 p.m.

Municipal and County Engineers, Town Hall, East Ham, E., 11 a.m. Mr. J. E. W. Birch, "The Public Works of East Ham."

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Journal of the Royal Society of Arts.

No. 3,108. VOL. LX.

FRIDAY, JUNE 14, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-Eighth Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the By-laws, on Wednesday, June 26th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary.*

MEDALS FOR PAPERS.

The Council have awarded the Society's Silver Medal to the following readers of papers during the Session 1911–12.

At the Ordinary Meetings :—

ALGERNON E. BERRIMAN, "The Efficiency of the Aeroplane."

PROFESSOR G. W. OSBORN HOWE, M.Sc., M.I.E.E., "Recent Progress in Radio-Telegraphy."

CECIL THOMAS, "Gem Engraving."

H. A. ROBERTS, M.A., "Education in Science as a Preparation for Industrial Work."

F. MARTIN DUNCAN, "The Marine Biological Association, and some account of the Work it has accomplished."

THEODORE E. SALVESEN, "The Whaling Industry of To-day."

GEORGE FLETCHER, "Technical Education in Ireland."

E. D. MOREL, "British Rule in Nigeria."

ERNEST KILBURN SCOTT, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

In the Indian Section :—

J. TRAVIS JENKINS, D.Sc., Ph.D., Superintendent of Lancashire and Western Sea Fisheries, "Fisheries of Bengal."

E. A. GAIT, I.C.S., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

SIR JOHN O. MILLER, K.C.S.I., "The Central Provinces."

NEVILLE PRIESTLEY, Managing Director, South Indian Railway, "Indian Railways."

In the Colonial Section :—

W. A. LEGG, M.Inst.C.E., "Irrigation in South Africa."

ALAN H. BURGOYNE, M.P., "Colonial Vine Culture."

Of recent years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers :—

In the Ordinary Meetings :—

James Douglas, LL.D., "The Industrial Progress of the United States of America"; Cyril Davenport, F.S.A., "Illuminated MSS."; Leonard Hill, M.B., F.R.S., "The Influence of Ozone in Ventilation"; Frank Warner, "The British Silk Industry and its Development since 1903"; T. Thorne Baker, "Some Modern Problems of Illumination—the Measurement and Comparison of Light Sources"; William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

In the Indian Section :—

Colonel Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India."

In the Colonial Section :—

The Hon. John G. Jenkins, "Australian Railways."

The Council, however, desire to express their high appreciation of these papers by thanking their authors for them.

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THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

VIII.—The Society and the Fine Arts. (1755–1851.)

It has sometimes been suggested that the early offer of prizes to young artists was due to the fact that Shipley was a drawing-master, and that his principal object was to establish a society for the encouragement of painting and drawing, thereby serving his own professional interests. There is, however, no vestige of evidence of this in any of the Society's records. As before mentioned,† it was quite clearly stated that the reason for the offer was the belief of the founders of the Society that "the Art of Drawing is absolutely necessary in many employments, trades, and manufactures." It will also be remembered that Shipley himself controverted in the *Gentleman's Magazine*, in 1756, the idea that the intention of the Society was to train young people as artists, and declared that its main object was to fit young people for the pursuit of the industrial Arts.

The history of the origin of the Society's Fine Art prizes has already been told in the first article of this series.* It was there recorded how, out of the limited funds subscribed for the purpose of offering prizes, a certain portion was devoted to rewards for young people of both sexes in drawing, and how the first prizes were taken by Cosway the painter, Smart the engraver, Gresse the painter, and Barbara Marsden, the clever girl who afterwards married Meyer, one of the original members of the Royal Academy.

From this modest beginning there soon developed a well-organised system for the

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, November 3rd, 1911, January 12th, 19th and 26th, and April 5th, 1912.

† *Journal*, June 9th, 1911, p. 770.

* *Journal*, June 9th, 1911, p. 770.

Sherwin's Design used as a Frontispiece for Vol. I. of the "Transactions" (see p. 751).

encouragement of Pictorial Art, which lasted for very nearly a hundred years, and had very real influence on the growth of English Art.

The prizes were at first intended to encourage Industrial Art, Art applied to manufactures, but it is not difficult to trace the changes in the Society's plans, which ended in the development of a scheme for encouraging young artists pure and simple.

In the first list of premiums, a list published as an advertisement in the newspapers, but only preserved by the Society in MS., prizes are offered to boys and girls under the age of seventeen, for "the most ingenious and best fancied designs, composed of Flowers, Fruit, Foliage, and Birds, proper for Weavers, Embroiderers, or Callico Printers."

In the oldest printed list of premiums, that issued in 1758, the objects of the Society in including "Premiums for improving Arts, etc.," are very clearly set out. "Fancy, Design and Taste, being greatly assisted by the *Art of Drawing*, and absolutely necessary to all Persons concerned in Building, Furniture, Dress, Toys, or any other Matters where Elegance and Ornament are required," it is "judged proper" to offer certain prizes to young persons, according to a schedule carefully drawn out, for drawings of the Human Figure, Landscapes, Casts, etc. Some of these are confined to students in "The Academy for Painting, etc., in *St. Martin's Lane*"; others are open to candidates who had studied in the Duke of Richmond's gallery, and others were quite open.

In the same list, besides these prizes for drawing, etc., we find special offers for designs for weavers and calico-printers, cabinet-makers, and coachmakers, as well as for manufacturers of iron, brass, china, earthenware, or "any other Mechanic Trade that requires Taste." All these were for young people. There was also a prize for a copper medal, "the medallic Art being capable of great Improvement in this Nation," open to candidates a little older, but still under twenty-five. All this goes to show that the founders of the Society were anxious to encourage the application of Art to industry, and were fully conscious of the need existing at the time for such encouragement.

During the next few years the list was extended by the addition of engraving, mezzotint, etching, wood-engraving (with which is included engraving on type-metal), gem-engraving, cameo-cutting, modelling in pastes (cameos), bronze-casting, mechanical drawing, architectural design, furniture design, etc. Many prizes were awarded under these various heads (Bewick got a prize of seven guineas in 1775), but, on the whole, the response was hardly satisfactory. The number of entries in the purely artistic classes was far more numerous, and the result was that by 1778 all the technical subjects had been practically dropped out, and the list confined to the artistic classes alone—including, of course, all the methods of reproduction, engraving, modelling, carving, casting, etc., but omitting the industrial applications. No doubt the Society moved in the direction of least resistance, and endeavoured to supply what the public demanded; but it is impossible to suppress a feeling of regret that the work so well begun was not continued, and that a furth [illegible] was not made to improve the artistic quality of the various industrial products then being manufactured in rapidly increasing amounts in England.

However, the Committee of Polite Arts evidently took greater interest in Art pure and simple than in its industrial applications, though some of them must have seen the importance of encouraging the "Lower branches of the Polite Arts, such as drawings for Patterns for Silk-weavers and Callico-printers," for in the observations appended in the list of Fine Art awards in the "Register of Premiums," etc., published in 1778, credit is claimed for the work done by the Society in the promotion of the application of Art to textile manufactures.

> "The elegance of pattern adopted by them [weavers and calico-printers] may with justice be attributed in a great degree to the rewards and attention bestowed upon them by the Society."

Nevertheless, the Society stopped its rewards and turned its attention elsewhere, practically abandoning the whole field of industrial Art. Now and again prizes were offered for designs. In 1801 "chints" patterns were asked for, and copper-plate patterns for calico-printers, but both offers were dropped after a few years, and it may be said with truth that very little was done to advance industrial Art until, a hundred years later, Prince Albert told a deputation from the then newly-formed Council of the Society, that "The department most likely to prove immediately beneficial to the public would be that which encourages most efficiently the application of the Fine Arts to our Manufactures." The result of this advice was that the Council arranged a special list of prizes for artistic manufactures; among which was one for "A plain and cheap Earthenware Tea Service

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in one colour, consisting of Teapot, Basin, Milk-jug, Cup and Saucer, and Plate." This prize was taken by "Felix Summerly, of 12, Old Bond Street," the pseudonym or trade-name adopted by Henry Cole; and it has often been said that this tea-service was the origin of the 1851 Exhibition. Of this more will be said hereafter, for Cole's connection with, and services to, the Society belong to a much later chapter of its history.

The foundation of the Royal Academy in 1768 might seem to have left nothing for the Society of Arts to do, so far as the Fine Arts were concerned, and it is evident that those who were responsible for the direction of the Society's work were anxious to avoid any rivalry with the new Academy. They did not carry out the intention, which at one time appears to have been favoured, of confining the Society's work to the encouragement of industrial Art, and in all probability the suggestion was not very popular, and doubtless at the time appeared impracticable; but they did definitely restrict the artistic awards to young students either young people who "are intended hereafter to become artists," as the *Transactions* rather quaintly put it, or to young folk of the upper class who were studying Art as amateurs.

It appears to have been thought that the Society's work in encouraging Art might gradually have been dropped, and that it would have been taken over by the Royal Academy; but things worked out differently. The Academy wisely confined itself to the instruction of the best class of Art students, and insisted on a high standard in all whom it admitted to its instruction, while the Society continued to offer rewards to all who cared to enter for its competitions. The value of its work was soon realised. The rewards of the Society were evidently highly appreciated, and it became evident that there was a keen competition among the younger Art students for the Society's prizes, and that they provided a valuable incentive to such students, both professional and amateur.

At first only boys and girls were allowed to compete; then classes for rather older candidates were formed, and there were some special classes without limitation of age. But the general idea evidently was that the Society would be wise to confine its competitions to young people, so this was for the most part done; and at all events so far as drawing, painting and sculpture were concerned, the prizes were restricted to youthful candidates of both sexes. There were various classes, with various limitations of age, and from time to time the rules were modified. Sometimes special subjects were set; sometimes the young artists were allowed to choose their own. When they were permitted to send in works of their own choice they had to execute sketches of a similar character in the presence of examiners, to prove their capacity. The tests seem to have been quite fair, and the correctness of the adjudicators' judgment is sufficiently proved by the long list of distinguished artists who won the earliest successes in the Society's competitions.

At first nearly all the prizes were in money, but "In order to encourage a love of the Polite Arts, and excite an Emulation among Persons of

THE FELIX SUMMERLY TEA-SERVICE.*

* Reproduced by permission of Messrs. Bell & Sons from Sir Henry Cole's "Fifty Years of Public Work."

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Rank and Condition," there was included in the 1758 list an offer of a gold and a silver medal for drawings by "Young Gentlemen or Ladies under the age of Twenty," and a similar offer to those under sixteen. The same prizes were offered in the following year, but were not continued after that. In 1762, however, a still more exclusive class was introduced—perhaps the definition of "rank and condition" was found difficult—for gold and silver medals were offered for drawings by sons and daughters of peers or peeresses. This queer distinction was carried on almost, but not quite, continuously for many years, with the addition of another generation, grandchildren of the nobility being included. A good many awards were made under this regulation to youthful aristocrats.

In or before 1783 a class was added for "young gentlemen" or "young ladies," and it was added that it was intended for those who "may hereafter become Patrons or Patronesses of the Arts." It was not, therefore, open to professional artists or their children. The rules were varied from time to time, but the distinction of rank was kept up till 1839, after which the privileges of the nobility disappeared, and the only distinction drawn was between amateurs and professionals.

In the closing years of the eighteenth century the interest in this department of the Society's work evidently flagged. The number of premiums offered was not very large, and the list of awards was a short one. It seems likely that this was mainly due to the feeling before referred to, that the Royal Academy was the proper authority for controlling all Art education, and that the Society ought to relinquish to it the work it had initiated. However, it was soon found that there was a public demand for artistic education of a more elementary character than was provided by the Academy, and that the Society's prizes indirectly supplied this demand. The result was that the Society was influenced to provide what was demanded, and that the natural popularity of the Society's prizes led to great increase in the number of the awards. Whatever the cause, it is certain that this condition of things was soon changed, and by the end of the first quarter of the nineteenth century the section of "Polite Arts" had evidently grown to be the most popular part of the Society's work. As before mentioned, industrial Art, the application of Art to industry, received but scant attention. No doubt the Society was influenced by the general state of public opinion; but all branches of artistic industry were encouraged, so far as the award of prizes could encourage them. As regards drawing, painting, and sculpture, the prizes were confined to young people only; but in the case of such Arts as die-sinking, gem-engraving, cameo-cutting, casting in metals, wood-engraving, and even line or mezzotint engraving and etching, there were, as a rule, no limitations of age, and many of the best workers of the time looked for their recognition to the medals or premiums of the Society.

In the classes for drawing and painting the limitations of age (with a few rare exceptions in earlier years) were always preserved, the limit being twenty-five, though in some of the classes it was lower. By far the largest proportion of the prizes was taken by these young candidates, and contemporary press descriptions of the Society's prize distributions refer almost exclusively (when speaking of the Art awards) to the young people who came up to receive them from the President. So long as the system of premiums was continued, the award of prizes to young artists was an essential part of it. Even when it was being revised in the years before the 1851 Exhibition, with the avowed object of substituting the application of Art to industry for the cultivation of pictorial Art, the prizes for painting and drawing were not discontinued, and the names of numerous recipients of such prizes are to be found in the lists down to that of 1849. As mentioned in a previous article, there was no prize distribution of any sort in 1851; at the last distribution in 1853 only one solitary medal was given in the class of Fine Arts.*

On the whole, the result of the Society's efforts for the promotion of Art, during the first century of its existence, must be regarded as distinctly valuable. The same causes which gradually rendered less and less effective the general offer of prizes for inventions and discoveries, by no means applied in the case of Art. If the medals and money prizes of the Society had obviously no direct educational influence, they had without any question a very genuine value as a means of discovering hidden talent, as an incentive and stimulant to youthful effort, and as a much appreciated reward for success. Hundreds of young artists received from the Society the first recognition of their powers, and were thus encouraged to persevere in careers which in many cases led to reputation and success—in some to fame and fortune. And

* *Journal*, Vol. I. p. 365.

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the prizes given were often of large amount, so as to afford substantial assistance to young artists. Prizes of ten, fifteen, and twenty guineas were common, and when they recognised cases of unusual merit the Committee did not hesitate to grant sums of fifty or a hundred pounds.

The best evidence of the value of the Society's Fine Art awards is to be found in the following list, selected from the very much longer lists of prize-winners. In it an attempt has been made to pick out those who afterwards became professional artists, and attained some amount of success in their profession. Some other names of persons who attained eminence or reputation have also been included. It will be seen that the list contains a great number of Royal Academicians and Associates, amongst them three Presidents—Sir Thomas Lawrence, Sir Charles Eastlake, and Sir John Millais; many of the best-known English engravers; several celebrated sculptors; numerous architects of eminence; a large proportion of our best-known medallists and gem-engravers; and besides these a very large number of artists of distinction in all classes. There are also many of reputation in their day, but now forgotten, and some who showed promise in their youth not fulfilled in after years. The 450 or so names printed below have been collected out of a list of about 3,000 awards, extending over a period of ninety-five years, 1755 to 1849. In the mass this represents a very considerable amount of volunteer labour, carried out by a committee of artists and amateurs, and it may certainly be regarded as reflecting very great credit on the institution by whose members it was faithfully undertaken.

AUSTIN'S DESIGN USED AS A FRONTISPIECE FOR THE PREMIUM LIST FOR 1803 (see p. 737).

The task has been one of some difficulty, and has involved a certain amount of labour. Though pains have been taken to ensure accuracy, it is certain that there must be many errors and inaccuracies in the list. Completeness was not to be expected, and it can only be hoped that not many names of importance have been overlooked. In many cases identification was not found to be possible, and no doubt in others awards may have been attributed to the wrong persons.

The accounts of the subsequent careers of the prize-winners are mainly based on Redgrave's and Bryan's well-known dictionaries. The notes about some of the medallists and gem-engravers are taken from Forrer's "Dictionary of Medallists." * The "Dictionary of National Biography" has, of course, been invaluable, though only a small proportion of the candidates attained its standard of distinction. Graves's "Dictionary of Exhibitors" has supplied numerous references. Dossie's list of the Society's awards down to 1775 contains a certain amount of biographical information, but the notes are unfortunately very brief.

The Society's rewards in the class of "Polite Arts," as in all the other classes, were at first always pecuniary. In 1756 it was determined to provide also "Honorary Premiums" in the form of gold and silver medals, but this decision was not carried into effect until 1758, by which time, after a good deal of discussion, a design for the medal had been approved and a die cut. The first medals were awarded in December of that year, and amongst them was a gold medal to Lady Louisa Augusta Greville for a landscape-drawing in Indian ink. This was the only medal awarded in the Art class in 1758, but after that year the awards of medals became numerous, at first only to amateurs, but later

* This Dictionary has not yet reached letter R, but Mr. Forrer has very kindly supplied some information which will appear in the later volumes.

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to professional artists also. In 1766 it was decided to adopt a special sort of prize instead of medals or money for youthful candidates, and the "Honorary Palette" was devised. This was a miniature copy of an artist's palette, bearing on the obverse the Society's title, and on the reverse a scroll with the recipient's name. It was in two sizes (2½ inches and 2 inches long respectively), and was in gold and silver, sometimes in silver-gilt. The original restriction to young persons was not always observed.

In 1811 the "Isis Medal," a medal with the head of Isis, designed by Thomas Wyon, was introduced. At first it was intended to substitute this for the palette, but this idea was not carried out. Both medals and palettes were awarded for many years—in fact, as long as any Fine Art prizes were given; but it is not very easy to say what was their precise relative value. At the first institution of the medal, the two were of equal value, and the candidate was given the option of selection. The last award of a palette was in 1847. The Isis Medal was awarded in the last two distributions of awards in 1850 and 1853.* It will, therefore, be seen that the awards (other than money) given by the Society were:—The Society's medal (often called the "Large Medal"), in gold and silver; the Isis Medal (sometimes called the "Small Medal"), in gold and silver; the Palette, in two sizes and in both metals, also rarely in silver gilt. On a very few occasions the silver medal was "set in a gold border." There was also the Stock Medallion,† nearly always given for Architecture, but occasionally for Sculpture.

The "Premiums" mentioned in the following list are all money prizes. They vary in amount from £150 to a few pounds, when a given amount had to be divided in shares amongst a number of candidates. It has not been considered necessary, except in some special cases, to state the value of the prizes in the list. Sometimes a medal and a money prize were both given.‡

* In 1850 there were no Fine Art prizes, but the Isis Medal was given for some of the awards in Industrial Art. In 1853 it was given for some purely technical inventions.

† This was awarded under the bequest of John Stock, who in 1781 left £100 to the Society, with the condition that the interest should be applied for the promotion of Drawing, Sculpture, and Architecture.

‡ The subject with which this article deals was treated by Mr. H. B. Wheatley in the *Journal* in 1895 (Vol. XLIII. p. 797), and he gave a rather shorter but similar list, which has always been found both interesting and useful. The fact that, in order to ensure completeness, the whole work had to be done afresh, made the present writer's obligations to his predecessor rather less than he had hoped, but as far as possible he has utilised Mr. Wheatley's work, and has pleasure in acknowledging his debt.

Artists and others who received the Society's Medals and Prizes, 1755–1849.*

Absolon, John. Silver Palette in 1832 for a Portrait in Chalk. *Water-colour painter.* Treasurer N.W.C.S. Died 1895.

Adams, Francis. Premium in 1760 for a Drawing. *Portrait painter and engraver.* "Did not attain any excellence" (Redgrave).

Agar, John Samuel. Silver Palette in 1793 for Historical Drawing. *Portrait painter and engraver.*

Aglio, Augustine. Silver Medal in 1831 for a Bust. An Italian artist, who came to England in 1803 to assist William Wilkins, R.A., the architect of the National Gallery. Died 1857.

Alcock, J. Rutherford. Gold Medals in 1825 and 1826 for Anatomical Models in Wax (coloured). Sir Rutherford Alcock, K.C.B., Consul in China, and first Consul-General in Japan. He gave up medicine for diplomacy in 1837. He was for long a member of the Society, and from 1880 to 1883 one of its Vice-Presidents. In 1882 he read an important paper on the Opium Trade. He died in 1897.

Aliamet, Francis Germain. Premiums in 1764 and 1765 for Engravings. *Engraver.* Brother of the celebrated French engraver. Worked for Boydell and others. Died 1790.

Allason, Thomas. Gold Medallion in 1810 for a Design for an Academy of Arts. *Architect.* Alliance Fire Office in Bartholomew Lane said to be his chief work (Redgrave).

Andras, Catherine. Silver Palette in 1801 for Models of Princess Charlotte and of Lord Nelson. *Medallist.* Modeller in Wax to Queen Charlotte. Produced Portrait Medallions in the enamelled paste of Tassie (q.v.), under whom she probably studied.

Artaud, William. Silver Palette in 1776, 1777, and 1782 for Drawings. *Painter of portraits and historical pictures.* Exhibited at Royal Academy up to 1822.

Austin, Richard. Silver Medal in 1802, Silver Medal (and 10 guineas) in 1803, and Silver Palette in 1804 for Wood Engraving. The 1803 medal was for a wood-cut (reproduced on page 736), "England, Scotland, and Ireland receiving the offerings of Genius, alluding to the rewards of this Society," used as a frontispiece to the Premium List for the year (1803), and printed in Vol. XXI. of the *Transactions* (facing page 1). *Wood Engraver.* Pupil of Bewick. "He was a clever artist, and much employed by the booksellers, but he did nothing to promote the art" (Redgrave).

Bacon, John. Premium in 1759 (aged eighteen) for a figure of Peace; subsequent awards were made to him in 1760, 1761, 1764 (two), 1765, 1772,

* The Secretary will be grateful for any corrections in this list, or for references to any additional names which might be included.

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1774, 1776, 1777 and 1778, all for Casts or Models. In 1778 he was also presented with a Gold Medal in recognition of his gift to the Society of the statues of Mars and Venus. An engraving of his Mars, by Bartolozzi, is prefixed to Vol. V. of the *Transactions*, and one of his Venus to Vol. VII. *Sculptor*. R.A. Eminent and popular in his own day. Carried out many important works and monuments. The Mars and Venus are now in the Victoria and Albert Museum. Died 1799.

Baillie, Edward. Silver Medals in 1833 and 1837 for Enamel Painting. *Glass painter*. Exhibited in 1851 exhibition. Died 1856.

Baily, E. Hodges. Silver Medal in 1808 for a Plaster Cast of the Laocoon. A pupil of Flaxman. *Sculptor*. R.A. Retired 1863 and died 1867.

Ballantyne, John. Silver Medal in 1833 for a Drawing from an Antique Statue. *Copyist and Portrait Painter*. R.S.A. Died 1897.

Banks, Charles. Premiums in 1764, 1765, 1767 and 1768 (two) for Bas-reliefs. *Sculptor*. Brother of Thomas Banks, R.A. R.A. Gold Medallist 1774. Exhibited at Royal Academy 1775–1792.

Banks, Thomas. Premiums in 1763, 1765 and 1766 for Bas-Reliefs; Premiums in 1769 for a Cast and for a Design for Furniture. *Sculptor*. R.A. Monuments in St. Paul's and in Westminster Abbey. "Takes high rank among England's sculptors" (Redgrave). Died 1805.

Barney, Joseph. Silver Palette in 1774 for a Drawing of Flowers; Gold Palette in 1781 for Historical Drawings. *Fruit and flower painter*. Exhibited at Royal Academy 1786–1827. Drawing Master at Royal Military Academy.

Barralet, John James. Gold Palette in 1774 for a Landscape. *Water-colour painter*. Exhibited at Royal Academy from 1770. Died in America about 1812.

Barret, George. Premium in 1764 (£50) for a Landscape Painting. *Landscape painter*. R.A. One of the founders of the English school of water-colour painting. A painter who "enjoyed great reputation in his lifetime, which his works have not since maintained" (Redgrave). Died 1784.

Barret, Joseph. Gold Palette in 1775 for an Ornamental Design. Gold Palette in 1777 for Landscape Drawing. *Landscape painter*. Son of George Barret, R.A. Exhibited at Royal Academy 1785–1800.

Barron, Hugh. Premiums in 1759, 1761, 1765 and 1766 for Drawings. *Portrait painter*. Exhibited at Royal Academy 1782–1786. "The first amateur violinist of his day" (Redgrave). Died 1791.

Barron, William Augustus. Premium in 1766 for a Chalk Drawing; Silver Palette in 1774 and Gold Palette in 1775 for Landscapes. *Landscape painter*. Brother of Hugh Barron and like him a musician. Exhibited at Royal Academy 1774–1777.

Barry, James, R.A. Gold Medal and 200 guineas in 1798, "In testimony of his public zeal and eminent abilities, manifested in the series of Pictures in the Great Room of the Society."

Bassett, Henry. Gold Medal in 1823 for a Design for British Museum; Gold Medallion in 1825 for a Design for a Church. *Architect*. Exhibited at Royal Academy down to 1844.

Beauvais, John. Premium in 1765 for a Drawing. *Miniature painter*. A native of France. "Practised with success as a miniature painter at Bath" (Redgrave).

Behnes, William. Silver Medal in 1814 for an Outline of the Gladiator Repellens; Gold Medal in 1819 for the invention of an Instrument for Transferring Points to Marble. *Sculptor*. He was originally a portrait painter, but afterwards obtained considerable fame as a sculptor, and was specially successful with his busts. Exhibited at Royal Academy 1815–1863. Died 1864.

Bellingham, John. Premiums in 1758 and 1759 for Ornamental Designs; in 1760, 1761 and 1763 for Drawings. *Draughtsman and drawing-master*.

Bentley, Charles. Silver Medal in 1826 for Landscape in Water-colour. *Water-colour painter*. Member Water-colour Society and constant exhibitor. Died 1854.

Benwell, Sarah. Silver Palette in 1806 for a Drawing. Mentioned by Peter Pindar. Redgrave thinks the poet really referred to her sister, Mary Benwell, a better known artist.

Berridge, John. Premiums in 1766 and 1767 for Drawings. *Portrait painter*. Pupil of Sir Joshua Reynolds. Exhibited at Royal Academy 1785.

Bewick, Thomas. Premium in 1775 (seven guineas) for an allegorical Vignette on Wood. The great wood-engraver must have been just out of his apprenticeship, as he was born in 1753. Died 1828.

Biffin, Sarah. Silver Medal in 1821 for an Historical Miniature. Miss Biffin, although born without hands or feet, succeeded in making a name for herself as a miniaturist.

Billings, Robert William. Six Medals for Architectural Pictures. Silver Medal in 1833 for a Drawing; Silver Medal in 1835 for an Engraving; Silver Medal in 1836 for a Water-colour Drawing; Silver Medal in 1838 for an Oil Painting; Gold Medal in 1837 for an Etching; Gold Medallion in 1839 for "an analysis of the great east window of Carlisle Cathedral." *Architect*. Writer on architecture and archæology. Died 1874.

Birch, William. Silver Palette in 1784 for Pictures in Enamel. *Enamel painter and engraver*. Went to America and died in Philadelphia. Painted miniature of Washington.

Blackmore, John. Silver Palette in 1772 for a Drawing. *Mezzotint engraver*. Engraved some of Sir Joshua Reynolds's portraits. Died about 1780.

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Blore, Edward. Silver Medal in 1809 for a Drawing of Fotheringham Church. *Architect.* F.R.S. Built Sir Walter Scott's house at Abbotsford. Architect to King William IV. and to Queen Victoria. Designed the front of Buckingham Palace. Died 1879.

Bond, John Daniel. Premiums in 1764 and 1765 for Landscapes. *Landscape painter.* "Resided chiefly at Birmingham, where he conducted the decorative branch of some large manufactory" (Redgrave). Died 1803.

Bonner, Thomas. Premium in 1763 for an Etching of a Landscape. *Topographical draughtsman and engraver.* Illustrated several topographical works. Exhibited at Royal Academy in 1807.

Bonomi, Joseph. Silver Medal in 1815 for a Bas-relief. *Architect.* Son of Joseph Bonomi, A.R.A.

Bouvier, Augustus Jules. Silver Medal in 1841 for a Chalk Drawing. *Water-colour painter.* Died 1881.

Boydell, John. Gold Medal in 1773 for Encouraging the Art of Engraving. *Engraver and publisher.* Published celebrated "Shakespeare Gallery." Lord Mayor 1790. Died 1804.

Brandenburgh, Anspach, and Bareith, etc., The Margravine of (previously Lady Craven). Silver Medal in 1806 for a Model in Bas-relief of the late Margrave.

Branston, Allen Robert. Silver Palette in 1806 and Silver Medal in 1807, both for Wood-engraving. *Wood-engraver.* Died 1827.

Branwhite, Charles. Silver Medal in 1837 for a Figure in Bas-relief. *Landscape painter.* Died 1880.

Brigstocke, Thomas. Silver Medal in 1826 for a Chalk Drawing; Silver Medal in 1827 for an Oil Painting. *Portrait painter.* Exhibited at Royal Academy from 1842. Died 1881.

Brockedon, William. Silver Medal in 1823 for a Rest for painters engaged in minute work. *Subject and history painter.* He was an F.R.S. and made various inventions, some of which were patented. He received another Medal for a Surgical Apparatus in 1825. He was Chairman of the Committee of Polite Arts from 1824 to 1831. "He displayed no ordinary talent in the various departments of painting — historical, landscape, and portrait" (Bryan). His portrait by himself is in the Uffizi. Died 1854.

Bromley, James. Silver Palette in 1821 for an Etching. *Mezzotint engraver.* Engraved many well-known portraits. Died 1838.

Bromley, John Charles. Two Silver Palettes and a Silver Medal in 1808, 1809, and 1810 for Etchings. *Mezzotint engraver.* He was born in 1795, so that he cannot have been more than fourteen when he took his first prize. Died 1839.

Bromley, William, A.R.A. Gold Medal 1821 for an Historical Engraving. This was not an award to a student, for Bromley had been an Associate Engraver of the Royal Academy since 1819. He was the father of J. C. Bromley and of James Bromley. Died 1842.

Browne, Hablot. Silver Medal in 1832 for a Group of Figures in Pencil; Silver Medal in 1833 for a "Free Etching of historical composition." Two years before he gained his first medal (at the age of seventeen) he began the association with Dickens on which his reputation was founded. Under the well-known signature of "Phiz" he illustrated the latter part of "Pickwick," "Nicholas Nickleby," "Martin Chuzzlewit," "Dombey," "Copperfield," "Bleak House," "Little Dorrit," and "A Tale of Two Cities" (Bryan). Died 1882.

Browne, John. Premium in 1763 for a Drawing. *Engraver.* A.R.A. Apprenticed to Tinney the printseller, and to Woollett. Exhibited at Royal Academy 1771–1783. Died 1801.

Bryer, Henry. Premium in 1762 for an Etching. Premiums in 1763 and 1764 for Engravings. *Engraver.* Engraved some of Angelica Kauffman's pictures. Pupil and partner of W. W. Ryland. Died 1799 according to Redgrave and Bryan, but Dossie in the list published in 1783 speaks of him as dead.

Bunning, James Bunstone. Silver Medal in 1822 for a Drawing of Bow Church. *Architect.* Surveyor to Foundling Hospital, architect to Corporation of London. Amongst his chief works were Billingsgate Market, Coal Exchange, Islington Cattle Market. Died 1863.

Burch, Edward. Premiums in 1762, 1763 and 1765 for Gem Engraving. *Sculptor and medallist.* R.A. "As a gem engraver he was unrivalled in his day" (Redgrave). Died 1814.

Burgess, Thomas. Silver Palette in 1771 and 1773 for Drawings. *Portrait painter and teacher.* "Mr. Burgess's Academy in Maiden Lane produced many able claimants for the Society's awards" (Dossie). Exhibited at Royal Academy 1778–1786.

Burgess, William. Premium in 1761 for a Drawing. *Portrait painter and teacher.* He was connected with Thomas Burgess's Academy in Maiden Lane and was probably related to him. Exhibited at Royal Academy 1774–1799. Died 1812.

Burt, Albin R. Silver Medal in 1830 for a Portable Easel. *Engraver and portrait painter.* Produced a print of Emma, Lady Hamilton. Died 1842.

Buss, Robert William. Silver Medal in 1826 for a Portrait in Oil. *Portrait and subject painter.* Illustrated numerous books. Exhibited at Royal Academy 1826–1859. He was employed to make illustrations for "Pickwick" after the death of Seymour, and before Hablot K. Browne (Phiz) took up the work, but his engravings were not used. Died 1875.

Byrne, William. Premium in 1765 for an Engraving. *Landscape engraver.* Engraved Hearne's (q.v.) drawings for the "Antiquities of Great Britain." "May be justly ranked among our eminent engravers of landscape" (Bryan). Died 1805.

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Calvert, Frederick. Silver Medal in 1833 for an Oil Painting. *Topographic draughtsman.* Published various series of views, etc.

Carr, Johnson. Premiums in 1757, 1758, 1759 and 1764 for Drawings of Figures; Premiums in 1760, 1761 (two), 1762 and 1763 for Landscape Drawings. Pupil of Richard Wilson, R.A. He died young, at the age of twenty-two. "This promising young man, at the early period of twenty-one years, executed drawings equal to those of the ablest masters then in this country. He died, much regretted, in 1764" (Dossie).

Carter, James. Silver Medal in 1819 for Architectural Drawing. *Engraver.* Engraved for the Annuals and for the Art Union. Died 1855.

Casali, Andrea. Premiums (100 and 50 guineas) in 1760, 1761, 1762 and 1766 for Historical Oil Paintings. *Historical painter.* Casali was an Italian who came to England before 1748, and returned to Italy about 1766. He painted an altar-piece for the Foundling Chapel, some pictures for St. Margaret's, Westminster, some ceilings at Fonthill, etc.

Chalon, Maria Ann. Silver Palette in 1813 for a Drawing; Silver Medal in 1818 for a Painting. *Miniature painter.* Daughter of H. B. Chalon, the animal painter. She was miniature painter to the Duke of York, and an exhibitor at the Royal Academy.

Chamberlin, Mason. Premium (50 guineas) in 1764 for an Historical Oil Painting. *Portrait painter.* R.A. His portrait of Dr. Hunter is in the Royal Academy, and his portrait of Dr. Chandler at the Royal Society. Died 1787.

Cheesman, Thomas. Silver Palette in 1781 for a Drawing; Gold Medal in 1814 for an Engraving. *Engraver and draughtsman.* One of Bartolozzi's best pupils. Exhibited drawings and portraits at Royal Academy 1802–1820. Engraved Hogarth's "Lady's Last Stake."

Clack, Richard Augustus. Silver Medal in 1825 for a Landscape; Silver Medal in 1826 for a Portrait. *Portrait painter.* Exhibited at Royal Academy 1830–1856.

Clennell, Luke. Gold Palette in 1806, and Gold Medal in 1809, both for Wood Engraving. *Wood engraver and subject painter.* He was apprenticed to Bewick, and succeeded as a wood-engraver, but abandoned that art for painting. Exhibited at Royal Academy 1812–1816. Became insane in 1817. Died 1840.

Clevely, John. Premium in 1765 for a Sea Painting in Oil. Silver Palette in 1774 for a View of a Castle in the Isle of Wight. *Marine painter.* Exhibited at Royal Academy 1770–1786. Draughtsman to Captain Phipps's Arctic Expedition, and illustrated the Journal of the voyage. Died 1786.

Clint, George. Gold Medal in 1819 for an Historical Engraving. *Portrait painter and engraver.* A.R.A. Died 1854.

Clint, Raphael. Gold Medal in 1825 for an Intaglio of a Head. *Gem engraver.* Son of George Clint, A.R.A. "Possessed considerable talent" (Bryan).

Clint, Scipio. Gold Medals in 1824 and 1826 for Medal Dies. *Medallist.* Son of George Clint, A.R.A. Medallist to the King. Died 1839 at the age of thirty-four.

Coleman, William. Premiums in 1775, 1776 and 1777 for Engraving on Wood. *Wood engraver.* Died 1807.

Collyer, Joseph. Premium in 1761 for a Drawing. *Engraver.* A.R.A. Engraved some of Sir Joshua Reynolds's portraits, also for Boydell. He was about thirteen when he took the prize. Died 1827.

Cook, Richard. Gold Palette in 1802 for a Drawing of Mucius Scævola. *History painter.* R.A. Died 1857.

Cook, Thomas. Premium in 1761 for a Drawing; Silver Palette in 1770 for a Drawing. *Engraver.* "Rose to the very top of his profession" (Redgrave). Worked for Boydell. Died 1818.

Cooley, Thomas. Premiums in 1763, 1764 and 1765 for Architectural Designs. *Architect.* Built the Royal Exchange in Dublin, and other buildings in Ireland. Died 1784.

Cope, Charles West. Silver Medal in 1828 for a Finished Drawing from a Statue; Silver Medal in 1829 for an Oil Painting. *Historical painter.* R.A. The portrait of Prince Albert in the Society's meeting-room was painted by Cope. Died 1890.

Corbaux, Fanny. Silver Medal in 1827, and Gold Medal in 1830 for Miniatures; Silver Medal in 1829 for a Water-colour. *Water-colour painter.* Exhibited numerous pictures at Royal Academy, and also at the New Water-Colour Society. Writer on Oriental Subjects and Biblical Exegesis. Died 1883.

Corbaux, Louisa. Silver Medal in 1828 for a Drawing; Silver Medal in 1829 for a Water-colour. *Water-colour painter.* Sister of Fanny Corbaux. Exhibited at Royal Academy, but more frequently at New Water-Colour Society.

Corbould, George. Silver Palette in 1806 for a Drawing. *Engraver.* Brother of H. Corbould. Died 1846.

Corbould, Henry. Gold Palettes in 1804 and 1805, both for Historical Drawings. *Historical painter and draughtsman.* He prepared the drawings of the Elgin Marbles. Died 1844.

Cosway, Richard. Premium in 1755 for a Drawing in Chalk, the First Prize in the Society's first competition; Premium in 1757 for an Ornamental Design; Premiums in 1758, 1759 and 1760 for Drawings. *Miniature and portrait painter.* R.A. A pupil of Shipley. The Society possesses two portraits by him, Shipley and Templeman. Died 1821.

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Cotman, John Sell. Silver Palette in 1800 for a Drawing. *Landscape and marine painter.* Worked both in oil and water-colour. Exhibited at Royal Academy. Lived some time in Norfolk, and much of his work was done in that county. Died 1842.

Cousins, Samuel. Silver Palette in 1813, and Silver Medal in 1814, both for drawings. His first award was obtained when he was eleven years old. *Engraver.* R.A. "His *œuvre* consists in all of about 200 plates" (Bryan). An apprentice and assistant of S. W. Reynolds, the engraver, he lived to engrave Millais's "Cherry Ripe." Died 1887.

Crellin, Henry Pickersgill. Premium in 1820 for a Drawing. Nephew of H. W. Pickersgill, R.A. Did not follow artistic pursuits, but practised as a medical man. Brother of H. N. Crellin. Died about 1843.

Crellin, Horatio Nelson. Premium in 1819 for a Drawing. *Engraver.* Gave up the pursuit of Art and became a medical man. Died about 1881.

Cross, Richard. Premium in 1758 for a Drawing. *Miniature painter.* Exhibited at Royal Academy 1770–1795. Died 1810.

Dall, Nicholas Thomas. Premium in 1768 for a Landscape. *Landscape painter.* A.R.A. He was a Dane, and settled in London about 1760. Was a scene painter at Covent Garden Theatre before his election into the Royal Academy. Died 1777.

Daniell, Thomas. Premium in 1780 for Landscape Painting. *Landscape painter.* R.A. Painted in India for ten years, and made his reputation by Indian views. Died 1840.

Davis, John Scarlett. Silver Palettes in 1816 for an Engraving, and in 1821 for a Head in Pen-and-Ink. *Subject painter.* Successful as a painter of interiors. Exhibited at Royal Academy 1825–1841. Died 1841.

Dean, Hugh Primrose. Premium in 1765 for a Landscape. *Landscape painter.* Exhibited at Royal Academy 1777–1780. Died about 1784.

Deare, Joseph. Silver Medal in 1823 for a Plaster Model. Two Silver Medals in 1824 for a Bas-relief, and for a Copy of a Group. *Sculptor.* Exhibited at Royal Academy 1825–1832.

De la Motte, William. Silver Medal in 1821 for an Etching. *Water-colour painter.* Pupil of West. Exhibited at Royal Academy 1796–1848. Drawing-master to Royal Military Academy. Died 1863.

Denman, J. Flaxman. Silver Palette in 1822 for a Drawing in Indian ink. *Subject painter.* Exhibited at Royal Academy in 1839. Presumably a relation of Mrs. Flaxman.

Denman, Maria. Silver Medal in 1807 for her Drawing of Flaxman's Design for the Society's Medal, printed as the Frontispiece to Vol. XXV. of the *Transactions;* Silver Medal, also in 1807, for "a Beautiful Plaster Model of a Cupid's Head." She was the sister of Flaxman's wife, and his adopted daughter. She founded the Flaxman Gallery at University College, London.

Denman, Thomas. Silver Palette in 1807 for a Plaster Model. *Sculptor.* Exhibited at Royal Academy and elsewhere 1815–1837. Possibly Mrs. Flaxman's brother.

Derby, Louisa. Silver Medal in 1828 for a Pencil Drawing of a Landscape by Claude. She afterwards married Henry Room, a portrait painter of some reputation. Their eldest son, Howard Henry Room, was a valued official of the Society from 1861–1900.

Devis, Antony. Premium in 1763 for a Landscape. *Landscape painter.* Exhibited at Royal Academy 1772 and 1781. Died 1817.

Dickinson, William. Premium in 1767 for a Mezzotint of R. E. Pine's Portrait of King George II. *Engraver.* Engraved after West, Morland, Stubbs, Reynolds, etc. Died 1823.

Dighton, Denis. Silver Medals and Palettes in 1807, 1808, 1810 and 1811 for Drawings and an Oil Painting (Battle of Agincourt). *Battle painter.* Exhibited at Royal Academy 1811–1825. Son of Robert Dighton. Died 1827.

Dighton, Robert. Silver Palette in 1768 for a Fancy Head in Pen-and-Ink after Worledge. *Portrait painter and drawing master.* Exhibited at Royal Academy 1775–1777. Died 1814.

Dobson, William Charles Thomas. Silver Medal in 1841 for an Oil Painting, "The Prodigal Son." *Painter in oil and water-colour.* R.A. Died 1898.

Donaldson, John. Premium in 1764 for an Historical Painting; two Premiums in 1768 for Enamels. *Miniature painter.* Apparently a man of varied accomplishments, but unsettled and wanting in application. He seems to have failed in life, and died in poverty 1801.

Donaldson, Thomas Leverton. Silver Medal in 1815 for an Original Architectural Design. *Architect.* P.R.I.B.A. Author of works on architecture. Died 1885.

Downman, John. Premium in 1779 for an Historical Painting. *Portrait and subject painter.* A.R.A. Died 1824.

Dubourg, Richard. Premium in 1755, at the first of the Society's competitions, at the age of fourteen, for a Drawing. Dossie says that he devoted himself to the reproduction of examples of ancient Italian architecture, and had some sort of exhibition of reproductions in cork of "Venerable Remains of Antiquity." His name does not appear in Redgrave or Bryan.

Dunkarton, Robert. Premiums in 1761, 1762, 1763, 1764, 1765 and 1766 for Drawings of various sorts; Premium in 1767 for an Engraving of Chamberlin's Portrait of Dr. Chandler, the antiquary and traveller (now in the possession of the Royal Society). *Mezzotint*

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engraver. Exhibited portraits at Royal Academy 1774-1779. "As a mezzotintist . . . he was rarely surpassed" (Redgrave). Engraved portraits by Reynolds, West, and others.

Durant, Susan. Silver Medal in 1847 for an Original Plaster Bust. *Sculptor.* Exhibited at Royal Academy 1847-1866. The Princess Louise was her pupil. Died 1873.

Durnford, Elias. Premium in 1755 for a Drawing of Flowers (third prize in the class between fourteen and seventeen); Premium in 1757 for an Ornamental Design. Went to America, and became Lieut.-Governor of Pensacola (Dossie).

Durno, James. Premiums in 1762 and 1765 for Drawings; Premiums in 1766, 1770 and 1773 (100 guineas) for Oil Paintings. *Historical painter.* Died in 1795 in Rome, where he lived from 1774.

Earlom, Richard. Premiums in 1757 (under fourteen years of age), 1758, 1759, 1760, 1761, 1762, 1763, 1764 and 1765 for Drawings in various classes; Premium in 1766 for an Etching. *Engraver.* A pupil of Cipriani, and afterwards one of the most distinguished of English engravers. "His 'Liber Veritatis,' comprising mezzotint engravings after 200 drawings by Claude, published in 1777, is well known" (Redgrave). Died 1822.

Eastlake, Charles Locke. Silver Medal in 1810 for a drawing of Cupid and Psyche. *Historical painter.* Sir Charles Eastlake, P.R.A. Director of the National Gallery. He acted as Chairman of the Society's Committee which procured the passing of the "Art Copyright Act, 1862." Died 1865.

Eckstein, John. Premiums in 1761 and 1764 (50 guineas) for Bas-reliefs. *Modeller and portrait painter.* Exhibited wax models and portraits at Royal Academy 1770-1798.

Eddis, Eden Upton. Silver Medal in 1828 for a Drawing. *Portrait painter.* Gold Medallist R.A. 1837. Exhibited at Royal Academy 1834-1881. Popular and successful artist. His portrait of Theodore Hook is in the National Portrait Gallery. Died 1901.

Edwards, Edward. Premium in 1762 for a Drawing; Premiums in 1764 and 1765 for Historical Pictures; Gold Medal in 1770 for an Historical Painting; Premium in 1781 for a Landscape. *Portrait and subject painter.* A.R.A. Teacher of perspective at Royal Academy. Published "Anecdotes of Painters," a supplement to Walpole's work. Died 1806.

Edwards, John. Premiums in 1757 for a Drawing; in 1760 for an Ornamental Design; in 1760 for a Landscape Drawing; in 1761, 1762, 1763, and 1767 for Drawings of Flowers; in 1764 for an Historical Drawing; Gold Palettes in 1769 for a Figure Drawing, and in 1771 for a Drawing of Flowers. *Historical and flower painter.* Pupil of Maberley.

Eggbrecht, John E. Silver Medal in 1821 for a Chalk Drawing; Silver Medal in 1824 for an Oil Painting. *Painter of still life.* Exhibited at Royal Academy 1826-1828.

Engleheart, Thomas. Premium in 1777 for a Model of a Human Figure. *Sculptor and modeller in wax.* Exhibited at Royal Academy 1773-1786. Gold Medallist R.A. 1772.

Engleheart, Timothy Stansfeld. Silver Palette in 1821 for a Chalk Drawing. *Line engraver.* Engraved for the annuals. Son of Francis. Died 1879.

Engleheart, William Francis. Silver Palette in 1798 for an Outline Drawing. *Engraver.* Engraved after Stothard, Cook and Smirke. Died 1849.

Ensom, William. Silver Medals in 1815 and 1816 for Pen-and-Ink Drawings. *Engraver.* Died 1832.

Fairland, Thomas. Silver Medals in 1822 and 1823 for Drawings. *Engraver, lithographer and portrait painter.* Died 1852.

Falconet, Peter. Premium in 1766 for an Historical Painting; Premium in 1768 for an Oil Painting. *Portrait painter.* Exhibited at Royal Academy in 1773.

Farey, Joseph. Silver Palette in 1809 for an "Original Drawing of a Steam Engine"; Silver Palette in 1809 for a "Perspective Drawing of London Bridge Water-works." *Engineer and draughtsman.* He was the son of John Farey, geologist and consulting surveyor, and the brother of John Farey, jun., a civil engineer of eminence, who received a Gold Medal from the Society for his ellipsograph. As a young man, John Farey supplied mechanical drawings to various works, and some of the illustrations in Vols. XXVI. to XXXI. of the *Transactions* are by him. It is possible that some may also be by Joseph, as the initials of the brothers are the same. Joseph Farey later on took over part of his brother's work. He died about 1829.

Farington, George. Silver Palette in 1770 and 1771 for Landscapes; Silver Palette in 1771 for a Drawing. *History painter.* Brother of Joseph Farington, R.A. Pupil of West. Gold Medallist R.A. 1780. Exhibited at Royal Academy in 1773 and 1783. Died 1788.

Farington, Joseph. Premiums in 1764, 1765 and 1766 for Landscape Drawings. *Landscape painter.* R.A. Illustrated Boydell's great work on the "History of the Thames." Died 1821.

Faulkner, B. Premiums in 1819, 1820 and 1822 for Die Engraving. *Medallist.* Forrer mentions several of his medals, all produced in or before 1826. He suggests that he may have been identical with B. R. Faulkner, a portrait painter of reputation, who exhibited at the Royal Academy 1821-1849, but this is improbable, for the Faulkner (or Faulkener) who took the prizes lived in Birmingham, whereas B. R. Faulkner was at the time living in Newman Street, London.

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Feary, John. Premiums in 1766 for a Drawing and in 1776 for a Landscape. *Landscape painter.* Exhibited at Royal Academy 1772–1788. Painted views of gentlemen's seats and parks.

Fennell, John G. Silver Medal in 1827 for a Chalk Drawing. *Engraver.* Pupil of Henry Sass. Superintended the Findens's establishment.

Finden, Edward. Silver Palette in 1810 for an Outline of the Laocoon. *Engraver.* Younger brother of William Finden. Died 1857.

Finden, William. Silver Palette in 1807 and Silver Medal in 1808 for Drawings; Gold Medal in 1813 for an Engraving. *Engraver.* The two Findens, Edward and William, worked together. They engraved some of Landseer's and Wilkie's works, and produced many illustrations for books. Died 1852.

Finlayson, John. Premium in 1764 for an Enamel Painting; Gold Palette (and 30 guineas) in 1773 for his Mezzotint of Sir Joshua Reynolds's Portrait of Lord Romney. *Mezzotint engraver.* Engraved Portraits after Hone, Coates, Zoffany and Reynolds. Died about 1776.

Flaxman, John. Premium in 1766 (at the age of eleven) for Modelling in Clay; Premiums (two) in 1769 for the same; Gold Palette in 1770 for Modelling a Statue of Garrick; Gold Medal in 1807 for Designing the Society's Medal and presenting it to the Society. In the latter year a Silver Medal was awarded to his sister-in-law, Miss Maria Denman (q.v.), for a Drawing of the Medal, which forms the Frontispiece to Vol. XXV. of the *Transactions* (1807). *Sculptor.* R.A. Died 1826.

Fox, Charles. Silver Medal in 1847 for an original Composition in Plaster. *Modeller.* Died 1854.

Freebairn, Alfred Robert. Silver Palette in 1810 for a Drawing. *Engraver.* "Chiefly known by his engraving of Flaxman's 'Shield of Achilles'" (Bryan). Died 1846.

Frith, William Powell. Silver Medal in 1836 for Drawing in Chalk from a Bust; Silver Medal in 1837 for a finished Drawing from a Cast. *Subject painter.* R.A. Painter of the celebrated and popular pictures, "The Derby Day," "The Railway Station," "Margate Sands," etc. Frith was born in 1819, so he must have been about seventeen when he received his first award. Died 1909.

Frost, William Edward. Silver Medals in 1829, 1830 and 1831 for Drawings; Silver Medal in 1832 for Composition in Oil in Still Life; Gold Medal in 1834 for a Portrait in Oil. *Subject painter.* R.A. Died 1877.

Gahagan, Sebastian. Premium in 1777 for a Model. *Sculptor.* Assistant to Nollekens. Exhibited at Royal Academy 1816–1835. The Duke of Kent's statue at the top of Portland Place is by him.

Gandon, James. Premiums in 1757 for a Drawing; in 1758 for a Design for Weaving; in 1759 for a Landscape; in 1762, 1763 and 1764 for Architectural Designs. *Architect.* Exhibited at Royal Academy 1774–1780. Carried out important works in Dublin. Died 1823.

Gardner, Rev. John. Premium in 1767 for a Landscape in Oils. *Amateur.* Vicar of Battersea. Died 1808.

Garvey, Edmund. Premiums in 1769 and 1771 for Landscapes. *Landscape painter.* R.A. Died 1813.

Geddes, Margaret. Silver Medal in 1812; Gold Medals in 1813 and 1814 for Oil Paintings. *Portrait painter,* "who secured great reputation" (Bryan). She married W. H. Carpenter, Keeper of Prints and Drawings in the British Museum. Three of her portraits are in the National Portrait Gallery. Died 1872.

Godby, James. Silver Palette in 1787 for an Outline Drawing. *Engraver.* Illustrated "Fine Arts of the English School," 1812, etc.

Goldicutt, John. Silver Medallion in 1815 for an Architectural Design. *Architect.* Secretary R.I.B.A. Published an account of the Pompeian paintings, etc. Died 1842.

Gooch, Thomas. Silver Palette in 1778 for Drawings of Animals. *Animal painter.* Exhibited at Royal Academy 1781–1802, principally portraits of horses and dogs.

Goodall, Edward. Silver Medal in 1837 for a Water-colour Painting. *Water-colour painter.* Brother of F. Goodall, R.A.

Goodall, Frederick. Silver Medal in 1837 for Water-colour Drawing; Silver Medal in 1838 for Oil-painting, "Interior of Thames Tunnel." He was not sixteen when this, his first oil-painting, was produced. It led to a friendship with Sir Isambard Brunel and to a visit to Normandy, where he found the materials for his first Royal Academy picture, "French Soldiers Playing at Cards," exhibited 1839. From that date his career was one of successful and deserved popularity. *Subject painter.* R.A. Died 1904.

Gott, Joseph. Silver Palette in 1808 for Original Plaster Cast. *Sculptor.* Gold Medallist R.A. 1819. Exhibited at Royal Academy 1820–1848.

Graham, George. Silver Palette in 1780 for a Drawing. *Engraver.* Produced book illustrations, etc.

Grant, William. Silver Palette in 1837 for a Pencil Drawing. *Historical painter.* Exhibited at Royal Academy 1847–1866. Died 1866.

Green, Benjamin Robert. Silver Palette in 1824 for a Chalk Drawing; Silver Medal in 1825 for an Outline Drawing; Silver Medal in 1827 for a Portrait in Oil. *Water-colour painter.* Died 1876.

Gresse, John Alexander. Premium in 1755 (aged twelve) for a Drawing; Premiums in 1756, 1757, 1758, 1759 (three), 1761, and 1762 for Drawings; Premium in 1769 for a Landscape

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in Oils. *Water-colour painter.* Fashionable drawing-master. Taught the daughters of George III. Died 1794.

Greville, Lady Louisa Augusta. Gold Medals in 1758, 1759 and 1760 for Drawings. She was the first to take one of the honorary awards offered to amateurs. Gold Medal in 1759 for an Etching. She was a daughter of the eighth Earl of Warwick, and an amateur of considerable skill who produced some good etchings.

Grignion, Charles. Premium in 1765 for a Drawing; Silver Palette in 1768 for a Drawing. *Portrait and history painter.* Son of Thomas Grignion, the clock-maker. Gold Medallist R.A. 1776. Painted Nelson's portrait. Exhibited at Royal Academy 1770–1784 Died 1804.

Grignion, Thomas. Premium in 1761 for a Drawing. This was the son and successor of Thomas Grignion, one of the earliest members of the Society, an eminent clock-maker, and the donor of the clock now in the meeting-room. Thomas Grignion the younger was also a well-known clock-maker.

Gwilt, George. Silver Palette in 1818 for a Drawing. *Architect.* Best known by his restoration of St. Saviour's Church, Southwark (1822-25). Died 1856.

Habershon, Matthew. Silver Medallion in 1813 for a Design for a Palace. *Architect.* Built several churches, public buildings, and country houses in Derbyshire, Yorkshire, Worcestershire, etc. Exhibited at Royal Academy 1807–1827. Published "Ancient Half-timbered Houses of England," 1836. Died 1852.

Hakewell, John. Premiums in 1759, 1760, 1761, 1762, 1763 and 1764 for Drawings in Various Classes; Silver Palette in 1772 for a Landscape. *Landscape and portrait painter.* Exhibited at Royal Academy 1765–1773. Died 1791.

Hall, John. Premium in 1756 for a Drawing; Premium in 1761 for an Engraving. *Engraver.* Engraved after West, Reynolds, Gainsborough, Hoare, and Dance. "Ranks among our best historical engravers" (Redgrave). Died 1797.

Hamilton, Hugh Douglas. Premiums in 1764, 1765 and 1769 for Historical Picture and Oil Paintings. *Portrait painter.* R.H.A. Died 1806.

Handasyde, Charles. Premiums in 1765 and 1768 for Enamel Paintings. *Miniature and enamel painter.* Exhibited at Royal Academy in 1776.

Harding, James Duffield. Silver Medal in 1815 for a Drawing; Silver Medal in 1818 for an Original Landscape. *Water-colour painter.* Died 1863.

Hardwick, Philip. Gold Medallion in 1809 for Original Drawing of an Academy of Arts. *Architect.* R.A. Amongst his principal works were Euston Square Station, the Goldsmiths' Company's Hall, and Lincoln's Inn Hall and Library. Died 1870.

Hart, Solomon Alexander. Silver Medal in 1862 for a Finished Drawing from a Statue. *Subject painter.* R.A. Exhibited from 1826 to 1880. Librarian of the Royal Academy for some years. He was about twenty when he gained the medal. Died 1881.

Hassell, Edward. Silver Medal in 1828 for an Oil Painting of the Altar-piece of St. Margaret's; Silver Medal in 1829 for Painting of Interior of Edward the Confessor's Chapel. *Landscape painter.* Secretary to Society of British Artists. Most of his exhibits were interiors of Gothic cathedrals. Died about 1852.

Hassell, John. Silver Medal in 1810 for Improvements in Aquatint. *Draughtsman and Engraver.* Worked in aquatint. Published Illustrated Guide to Bath, and some other works.

Hayter, George. Silver Medal in 1821 for an Etching from a picture by Titian. Sir George Hayter, *Portrait and Historical painter.* He was appointed Portrait and History Painter to Queen Victoria on her accession. Died 1871.

Head, Guy. Silver Palettes in 1781 and 1782 for Historical and Landscape Drawings. *Portrait painter.* Resided many years in Rome. "Best known as a copyist" (Redgrave). Died 1800.

Hearne, Thomas. Premiums in 1763 for a Drawing, in 1764 for a Drawing of a Horse, in 1765 for an Etching, in 1767 for a Landscape; Gold Palette in 1776 for a Landscape in Oils. *Water-colour painter.* Worked first as an Engraver. Exhibited at Royal Academy 1765–1806. His drawings for the "Antiquities of Great Britain" were engraved by W. Byrne (q.v.). Died 1817.

Hebert, William. Premium in 1760 for a Flower Picture. *Engraver.* Published some landscapes.

Henderson, John. Premium in 1762 for a Drawing. *Engraver.* Pupil of Shipley. Abandoned his art and became a successful actor. Died 1785.

Henning, John. Silver Medal in 1816 for a Plaster Cast. *Modeller.* Copied some of the Elgin Marbles. Died 1851.

Hilditch, George. Gold Medal in 1823 for an Original Landscape in Oil; Silver Medal in 1824 for a Copy in Oil; Silver Medal in 1825 for an Original Picture (still life) in Oil. *Landscape painter.* Exhibited at Royal Academy 1823–1856. Died 1857.

Hoare, Prince. Premium in 1772 for a Flower Picture. *Portrait and historical painter.* Exhibited at Royal Academy 1781–1815. Son of William Hoare, R.A. Wrote several books on Art. Foreign Corresponding Secretary to Royal Academy. Died 1834.

Hodges, William. Premium in 1759 for Modelling in Clay; Premiums in 1762, 1763, and 1764 for River Views. *Landscape painter.* R.A. Errand-boy in Shipley's School. Appointed in 1772 draughtsman to Captain Cook's second expedition. Died 1797.

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Hodgson, Thomas. Premium in 1775 for Wood Engraving. *Wood engraver.* Employed by Bewick, and practised on his own account.

Hole, Henry. Gold Palette in 1804 for Wood Engraving. *Wood engraver.* Pupil of Bewick.

Hollis, Thomas. Gold Medal in 1837 for a Water-colour. *Draughtsman.* Son of George Hollis, engraver, and worked with him. Died 1843.

Hook, James Clark. Silver Medals in 1837 and 1838 for Drawings in Chalk; Silver Medal in 1840 for Two Portraits in Oil. *Marine painter.* R.A. Died 1907.

Hopwood, James. Silver Palette in 1803 for an Outline Drawing. *Engraver.* "Designed and engraved some clever book illustrations" (Redgrave).

Horsley, John Callcott. Silver Medal in 1830 for a Chalk Drawing from a Bust; Silver Medal in 1831 for a finished Drawing from a Statue. *Subject painter.* R.A. He painted the portrait of Queen Victoria and her children in the Society's meeting-room. As Horsley was born in 1817 his first award was taken when he was thirteen. Died 1903.

Horwell, Charles. Silver Palette in 1787 for a Figure of Psyche. *Sculptor.* Gold Medallist R.A. 1788. Exhibited at Royal Academy 1787–1807.

Howard, Frank. Silver Palette in 1822 for a Chalk Drawing. *Designer and draughtsman.* Son of Henry Howard, R.A. Exhibited at Royal Academy 1825–1847. Published various works, mostly manuals of instruction in Art. Died 1866.

Hughes, Edwin. Silver Palette in 1846 and Silver Medal in 1847 for Drawings. *Portrait painter.* Died 1908.

Hullmandel, Charles Joseph. Silver Medal in 1819 for Specimens of Lithography. This same year a gold medal was awarded to Senefelder for the invention of lithography. Hullmandel, who was an artist, took up lithography in 1818. From that time he devoted himself to it, and with great success. He introduced many improvements, and was associated with the production of many important works. Died 1850.

Humphreys, William. Premium in 1764 for a Drawing; Premiums in 1765 and 1766 for Mezzotints. *Engraver.* "His mezzotints . . . possess very high merit, and were esteemed among the best of the time" (Redgrave).

Hurlstone, Frederick Yeates. Silver Palette in 1812 for a Drawing; Silver Medals in 1813 and 1814 for Drawings; Silver Medals in 1816 and 1821 for Oil Paintings. *Portrait and history painter.* Exhibited at Royal Academy 1821–1845. Took Gold medal at Paris Exhibition 1855. President of the Society of British Artists. Died 1869.

Hurlstone, Richard. Premiums in 1763 and 1764 for Drawings. *Portrait painter.* Exhibited at Royal Academy 1771–1773. Died about 1774.

Inwood, Henry William. Silver Medal in 1816 for original Architectural Drawing. *Architect.* Joint architect with his father of St. Pancras Church. Exhibited at Royal Academy 1809–1838. Died 1843.

Ireland, Samuel. Premium in 1760 for a Drawing. *Engraver.* Exhibited at Royal Academy in 1782. Published several works. His son, William Henry Ireland, was the author of the famous Shakespearean forgeries. Died 1800.

Jeffereys, James. Gold Palette in 1774 for an Historical Drawing. *Marine painter.* Gold Medallist R.A. 1773. Exhibited at Royal Academy in 1783. Died 1784.

Jones, George. Silver Palettes in 1802, 1804, and 1805 for Drawings. *Battle and subject painter.* R.A. He was supposed to resemble the great Duke of Wellington, and acted the part. Died 1869.

Jones, Thomas. Premiums in 1764 and 1765 for Drawings; Premiums in 1767 and 1768 for Landscapes. *Landscape painter.* Exhibited at Royal Academy 1784–1798.

Jukes, Francis. Premium in 1778 for a "Map of Boston in Aqua Tinta." *Painter and engraver.* "Successful in aquatint, principally sea-pieces and landscapes" (Redgrave). Died 1812.

Keith, Elizabeth. Premium in 1755 for a Drawing. She obtained the second prize in the class between fourteen and seventeen in the Society's first competition. According to Dossie, she died young.

Kelsey, Charles Samuel. Silver Medal in 1846 for a "design for a ticket of admission to the Society's Rooms"; Silver Medal in 1847 for a figure. *Sculptor.* Exhibited at Royal Academy 1840–1877.

Kelsey, Richard. Silver Medal in 1819 for a design for a Mansion; Silver Medallion in 1820 for a design for a National Museum. *Architect.* R.A. Gold Medallist R.A. 1821.

Kendrick, Emma Eleonora. Silver Palette in 1811 for a Drawing; Silver Medal in 1812 for a Miniature; Gold Medals in 1814, 1815, 1816 and 1817 for Miniatures. *Miniature painter.* Daughter of Josephus Kendrick. Exhibited at Royal Academy 1811–1840. Miniature painter to William IV. Died 1871.

Kendrick, Josephus. Silver Medal in 1811 for a Plaster Cast. *Sculptor.* Gold Medallist R.A. 1813. Exhibited at Royal Academy 1813–1829.

Keyse, Thomas. Premium in 1764 for a method of fixing Crayon Drawings. *Painter of still life.* Keeper of Bermondsey Spa. Died 1800.

Kirby, Sarah. Premiums in 1757 and 1758 for Ornamental Designs. Daughter of Joshua Kirby, F.R.S., architect and writer on perspective. Afterwards Mrs. Trimmer, the once popular educational writer.

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Kirby, William. Premiums in 1760 for an Etching, and in 1761 for a Landscape Drawing. Son of Joshua Kirby, F.R.S. Died 1771.

Kirk, John. Premiums in 1759, 1762, and 1763, for Die Engraving. The 1762 premium (30 guineas) was for "the Seal for the Society's letters, after a design of Cipriani." *Medallist.* Died 1776.

Kirk, Thomas. Silver Palette in 1785 for Historical Drawing. *Painter and engraver.* Exhibited at Royal Academy 1785–1796. "An eminent artist," who "passed like a meteor through the region of art" (Dayes, quoted by Redgrave). Died 1797.

Kitchingman, John. Premiums in 1762, 1763, 1764, 1765 and 1766, and Gold Palette in 1770 for Drawings in various classes. *Miniature painter.* Pupil of Shipley. Exhibited at Royal Academy 1770–1781. Died 1781.

Lambert, James. Premium in 1770 for a Landscape. *Landscape painter.* Exhibited at Royal Academy 1774–1778. A well-known scene-painter and a friend of Hogarth. He was the first President of the Incorporated Society of Artists. Died 1779.

Landseer, Charles. Silver Palette in 1815 for a Drawing of the Laocoon. *Subject painter.* R.A. Brother of Sir Edwin Landseer. Died 1879.

Landseer, Edwin. Silver Palette in 1813 for Drawing of Animals from Life; Silver Medal in 1814 for a Drawing of a Horse; Silver Medal in 1815 for a Painting of a Dog; Silver Medal in 1816 for an original Painting, "The Stable Guardian." As he was born in March 1802 he was only eleven when he received his first award. The eminent and popular *Animal painter*, Sir Edwin Landseer, R.A. Died 1873.

Landseer, George. Silver Medal in 1841 for "Water-colour Drawings of Birds and Beasts from Nature"; Silver Palette in 1842 for an "Oil Painting of a Lion from Nature." *Portrait and landscape painter.* Only son of Thomas Landseer, A.R.A. Was in India from about 1844 to 1870. Died 1878.

Landseer, Miss. Silver Palette in 1813 for an Original Landscape. This was probably Jessica, daughter of John Landseer, R.A. (and sister of Edwin), who "used the painter's brush and the etching-needle," and "etched a few designs after her brother Edwin" (Bryan). Exhibited at Royal Academy 1816 and afterwards. Her younger sister Emma (Mrs. Mackenzie) did not begin to exhibit until 1838.

Landseer, Thomas. Silver Palette in 1810 for an "Etching of Sheep and Goats"; Silver Medal in 1813 for an "Etching of Animals"; Silver Medal in 1814 for a Painting of a Horse. *Engraver.* A.R.A. Eldest brother of Sir Edwin Landseer, many of whose pictures he engraved. Died 1880.

Lane, John Bryant. Silver Palette in 1806 and Gold Medal in 1807 for Historical Drawings. *Historical painter.* Exhibited sacred and classical subjects at Royal Academy 1808–1813. Then went to Rome and devoted fourteen years to the production of what he hoped would be a masterpiece, but proved a failure, "The Vision of Joseph." Afterwards he showed some portraits at the Royal Academy 1831–1834.

Lauranson, William. Premiums in 1760, 1761, 1762, 1763, 1764, 1765 and 1766 for Drawings. *Portrait painter.* Exhibited at Royal Academy 1774–1780.

Lawrence, Thomas. Silver Palette gilt and Five Guineas in 1784 for a Copy of the Transfiguration of Raphael. The committee found that the drawing had not been executed within the limit of time specified, and therefore that it was disqualified, and they consequently withheld the Gold Medal offered. Subsequently they decided to make the above-named award, "as a token of the Society's approbation of his abilities." The award, therefore, does not appear in the printed list. The only record of it is in the Society's minutes, and the committee minutes (Committee of Polite Arts, March 9th and 30th, 1784). The candidate was afterwards Sir Thomas Lawrence, P.R.A. He was not fourteen years of age when the award was made, as he was born in May 1769. Died 1830.

Lawrie, Robert. Premium in 1770 for a Drawing; Premiums in 1773, 1775 and 1776 for Ornamental Designs; Silver Palette in 1773 for a Study of Flowers; Bounty of 30 guineas in 1776 for Improvement in Mezzotint Colour Printing. *Engraver.* Died about 1804.

Leake, Henry. Premium in 1760 for a Drawing. *Portrait painter.* Pupil of W. Hoare, R.A.

Legrew, James. Silver Palette in 1822 for a Plaster Model. *Sculptor.* Pupil of Chantrey. Gold Medallist R.A. 1829. Produced many groups of merit. Died 1857.

Le Jeune, Henry. Silver Palette in 1834 for a Copy of a Figure in Indian Ink. *Historical painter.* A.R.A. Gold Medallist R.A. 1841. Died 1904.

Liart, Matthew. Premiums in 1764 and 1765 for Drawings. Premium in 1766 for an Engraving. *Engraver.* Died about 1782.

Lines, Samuel. Silver Medal in 1825 for Pencil Drawing. *Painter and drawing master.* One of the founders of the Birmingham School of Art. Died 1863.

Linwood, Mary, of Leicester. Silver Medal in 1786 "for submitting to the inspection of the Society, as examples of works of art, and of useful and elegant employment, three pieces of needlework, representing a hare, still life, and a head of King Lear." Miss Linwood opened her celebrated exhibition of embroidered pictures at the Hanover Square Rooms in 1798, and afterwards removed to Leicester Square, where her exhibition was considered one of the chief sights of London. Died 1845.

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Loat, Samuel. Silver Medal in 1825 and Gold Medal in 1827 for Architectural Designs. *Architect.* Gold Medallist R.A. 1827. Exhibited a design in 1831, "after which there are no traces of his art" (Redgrave).

Lochée, John Charles. Premium in 1775 (30 guineas) for a Statue; Premium in 1776 (50 guineas) for a Statue; Silver Medallion in 1790 for a Bust of the Prince of Wales (afterwards George IV.). An engraving of this bust forms the Frontispiece to Vol. X. of the *Transactions*. *Sculptor.* Exhibited at Royal Academy 1776–1790. Some portrait medallions by him were reproduced by Wedgwood and by Tassie.

Long, J. St. John. Silver Medal in 1825 for a Landscape. Brought up as engraver, but did not follow the profession. Not successful as an artist he set up as a quack doctor. Died 1834.

Lucy, Charles. Silver Medal in 1834 for an Oil Painting. *Historical painter.* Exhibited at Royal Academy 1838–1873. Most of his works related to the History of England, and were meritorious but not very successful.

Lupton, Thomas Goff. Gold Medal in 1822 for a Mezzotint on Soft Steel. He introduced the use of soft steel for mezzotint (see his paper, *Transactions*, Vol. XL. p. 41).* He worked both on steel and on copper, and produced many fine plates after Turner. Died 1873.

Malton, Thomas. Premium in 1774 for a Drawing of a Tide-Mill. *Architectural draughtsman.* Gold Medallist R.A. 1782. Published several topographical works and views. Died 1804.

Malton, William. Premiums in 1775 and 1777 for Drawings of Machines. *Architectural draughtsman.* Brother of Thomas Malton.

Manning, Samuel. Silver Medals in 1831, 1832 and 1838 for Busts; Gold Medal in 1833 for a Model of a Figure; Silver Medal in 1840 for a Group. *Sculptor.* Son of Samuel Manning, also a sculptor. There is some confusion in the books between father and son. According to the account in the "Dictionary of National Biography," which seems the most correct, the "Prometheus," for which the 1833 award was made, was shown in marble at the Royal Academy in 1845. Died 1865.

Marchant, Nathaniel. Premiums in 1761, 1762, 1763, 1764 (two) and 1765 for Engraved Gems. *Gem engraver and medallist.* R.A. Pupil of E. Burch, R.A. Engraver to the Mint. Designed some coins and medals. "Chief of English gem engravers of the eighteenth century" (King, quoted by Forrer). Died 1816.

Marsden, Barbara. Premiums in 1755 and 1756 for Drawings; Premiums in 1757 and 1758 for Ornamental Designs. She married Jeremiah Meyer, R.A. (q.v.). The 1758 award was in a class limited to candidates under fourteen, so she cannot have been twelve years old when she took the prize in 1755.

Martin, David. Premiums in 1759, 1760 and 1761 for Chalk Drawings. *Portrait painter and engraver.* Died 1798.

Martin, William. Gold Palette in 1776 for an Historical Drawing; Premium in 1780 for a Landscape. *History painter.* Pupil of Cipriani. Exhibited at Royal Academy 1775–1816. History painter to George III.

Mason, William. Silver Medal in 1776 for a Drawing of a Horse. *Animal painter.*

Masquerier, John James. Silver Palettes in 1794, 1795 and 1796; Silver Medal in 1799, all for Drawings. *Portrait painter.* Born at Chelsea of French parents. Studied in Paris. Pupil of Vernet. Exhibited at Royal Academy 1796–1838. Painted Napoleon's portrait. Died 1855.

Mayor, Barnaby. Premium in 1765 for a Landscape Etching. *Engraver and painter.* Died 1774.

Medland, Thomas. Silver Palettes in 1777, 1779 and 1780 for Drawings. *Engraver.* Illustrated numerous books. Exhibited at Royal Academy 1777–1822.

Metz, Conrad Martin. Gold Palette in 1783 for an Historical Drawing. A German artist who came to London.

Meyer, Jeremiah. Gold Medal in 1761 for Profile Likeness of George III. from memory, intended to be, but not actually, used in cutting a die for the coinage. Miniature Painter to the king. *Miniature painter.* R.A. Enameller to King George III. and Miniature Painter to Queen Charlotte. Married Barbara Marsden (q.v.), who took several of the Society's prizes. Died 1789.

Milbourn, John. Premiums in 1763, 1764 and 1765 for Drawings. *Portrait painter.* Exhibited at Royal Academy 1773 and 1774.

Millais, John Everett. Silver medals in 1839 for Drawing in Chalk from a Bust; in 1840 for an Historical Composition in Pencil; in 1841 for an Historical Composition in Sepia; Gold Medal in 1846 for an Original Historical Painting; Gold Medallion in 1847 for an Original Composition in Oil. *Subject, landscape and portrait painter.* Sir John Everett Millais, Bart., P.R.A. As Sir John Millais was born in 1829, his first award was obtained when he was only ten. Died 1896.

Miller, John. Premiums in 1764 for a Flower Picture; and in 1766 for an Engraving. *Flower painter and Engraver.* Published an illustrated botanical work, 1770–7.

* The credit of having produced the first mezzotint on steel has always been given to William Say, the mezzotint engraver, and it would appear with justice, since there is a mezzotint print by him, after a portrait of Princess Charlotte (daughter of George IV.) by G. Dawe, R.A., in the British Museum. The print was published by Dawe in 1817, and is said to be from a steel plate. The two inventors were probably working independently. There is nothing in Lupton's paper to suggest that his work was not original, and probably it was.

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Mills, George. Gold Medals in 1817 and 1818 for Medal Dies, and in 1823 for presenting the Society with a new Die for the Vulcan Medal. *Medallist.* Produced medals of General Moore, Watt, West, George IV., and Sir F. Chantrey. Exhibited at Royal Academy 1816–1823. Died 1824.

Mitchell, Thomas. Premium in 1766 for a Sea-piece. *Marine painter.* Exhibited at Royal Academy 1774–1789. Had appointments in the dockyards, and worked as an amateur.

Moore, Francis John. Premium in 1766 for an Allegorical Bas-relief; Silver Palette in 1769 for a Statue. *Sculptor.* Died 1809.

More, Samuel. Premiums in 1763 and 1764 for two sets of Impressions of Pastes resembling Antique Cameos and Intaglios. Afterwards Secretary of the Society.

Moring, Thomas. Gold Medal in 1845 for "an Engraving on White Cornelian." *Seal engraver.* Practised as a professional seal engraver and medallist. Died 1884.

Mortimer, John Hamilton. Premiums in 1759 (two), 1760, 1761 and 1762; Premium in 1763 (50 guineas) for an Oil Painting of Edward the Confessor taking his Mother's Treasures; Premium in 1764 (100 guineas) for St. Paul Preaching to the Britons. The last picture was placed as an altar-piece in the church of High Wycombe, Bucks, where the painter is buried. *History painter.* A.R.A. Died 1779.

Moser, George Michael. Premium in 1758 for "A Model, chased in gold, of an Honorary Medal proposed by him to the Society . . . afterwards engraved by John Kirk" (Dossie). *Enameller and modeller.* R.A. One of the founders of the Royal Academy, and its first Keeper. "Had high merits as an artist, excelling not only as a chaser, but as a medallist, and he painted in enamel with great beauty and taste" (Redgrave).

Moser, Joseph. Premiums in 1762, 1763 and 1765 for Modelling in Wax. *Enameller.* Nephew of G. M. Moser, R.A. Exhibited at Royal Academy 1774–1787. Afterwards a London Police Magistrate.

Moser, Mary. Premium in 1758 for an Ornamental Design; Premium and Silver Medal in 1759 for a Flower Picture. The Silver Medal was a special and additional award "presented to her as a further Reward for her extraordinary merit." *Flower painter.* R.A. Daughter of G. M. Moser, R.A. Original member of Royal Academy, and one of the two woman Academicians (the other being Angelica Kauffman). Married Captain Hugh Lloyd. Died 1819.

Moses, Henry. Silver Palettes in 1800 and 1801 for Drawings. *Engraver.* Produced plates after Barry, Northcote, Opie, and others. Died 1870.

Mulready, William. Silver Palette in 1801 for a Drawing. *Subject painter.* R.A. Mulready was born in 1786, so he was only fourteen at the date of the award. In 1848 a collection of Mulready's works was exhibited in the Society's house. Died 1863.

Nesbitt, Charlton. Silver Palette in 1798, and Silver Medal in 1802, for Wood Engraving. *Wood engraver.* A pupil of Bewick. Successful illustrator of numerous books. Died 1838.

Netherclift, Joseph. Premium in 1829 for Lithographic Transfer Paper. *Lithographer and printer.* This was the first practical transfer paper, for though the earliest lithographs made were transfers, the difficulties attending the process were so great that the work was all executed direct on the stone until a suitable paper was produced. Died 1863.

Nollekens, Joseph. Premium in 1759, at the age of eighteen, for a Drawing; Premiums in 1759, 1760, 1761 (two) and 1762 for Bas-reliefs. *Sculptor.* R.A. This celebrated sculptor amassed a large fortune by his work. His peculiarities are well known from the Life by Smith, "Nollekens and His Times." Died 1823.

Norton, Christopher. Premium in 1760 for a Drawing. *Engraver.*

Okey, Samuel. Premiums in 1765 and 1767 for Mezzotints. *Engraver.* Engraved after Sir J. Reynolds, Pine, and others.

Pain, George Richard. Gold Medal in 1812 for a Design for a Church; Silver Medal in 1813 for a Design for a Palace. *Architect.* Apprenticed to Nash. Went to Ireland about 1817, and practised there. Died 1838.

Papworth, Edgar George. Silver Medal in 1825 for a Pencil Drawing; Silver Palette in 1827 for a Bas-relief. *Sculptor.* Died 1866.

Papworth, John Woody. Silver Medal in 1838, Gold Medal in 1840, and Gold Medallion in 1845 for Architectural Designs. *Architect and heraldic painter.* Designed for glass, pottery, and textiles. Brother of Wyatt Papworth. Died 1870.

Papworth, Wyatt. Silver Medal in 1836, and Silver Palette in 1838 for Architectural Drawings. *Architect.* Editor of the "Dictionary of Architecture." Curator of Soane Museum. Died 1894.

Parke, Henry. Silver Medals in 1807, 1808, 1810, 1811, 1812; and Gold Medal in 1814 for sea-pieces. *Architect.* Pupil of Sir John Soane. Made many drawings of monuments of Italy and Egypt, and, according to Redgrave, "Some naval drawings of much ability." A collection of his drawings is preserved by the R.I.B.A. Died 1835.

Parker, John. Premiums in 1762 and 1763 (two in each year) for Drawings in different classes. *Landscape painter.* Exhibited at Royal Academy 1770–1778.

Parry, William. Premiums in 1760, 1761, 1762, 1763, 1764 and 1766 for Drawings in various classes. *Portrait painter.* A.R.A. Died 1791.

Pars, Albert. Premiums in 1759, 1764 and 1765 for Modelling in Wax; Premium in 1767 for a Bronze Cast. *Modeller.* Brother of William Pars, A.R.A. "Successful modeller in wax" (Redgrave).

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Pars, Anne. Premiums in 1764, 1765, and 1766 for Drawings. Sister of William Pars, A.R.A. Exhibited at Royal Academy in 1786.

Pars, William. Thirteen Premiums from 1756 to 1764 in various classes, including Drawings of Landscapes, Animals, Still Life, and Ornamental Design, Wax Modelling, and an Oil Painting. In 1757 he was admitted to the class under fourteen, so he cannot have been thirteen when he took his first award. *Portrait painter.* A.R.A. Produced also Views of Temples in Greece and in Asia Minor, and some Swiss views. Brother of Henry Pars, Shipley's successor as the Master of the Academy in the Strand. Died 1782.

Parsons, William. Premiums in 1757, 1758 and 1760 for Drawings. *Portrait painter (amateur).* Died 1795.

Patmore, Coventry. Silver Palette in 1838 for a Pencil Drawing. The well-known poet. He contributed to the *Germ*, and was a friend of the first pre-Raphaelites, but does not appear to have continued his artistic studies or work. Died 1896.

Patten, George. Silver Palette in 1816 for a Miniature. *Portrait and history painter.* A.R.A. Exhibited at Royal Academy, 1819 to about 1865. Portrait painter in ordinary to Prince Albert. Died 1865.

Pearson, Mrs. C. Silver Palette in 1816; Silver Medal in 1817; Gold Medal in 1819 for Oil Paintings. *Portrait painter.* Exhibited at Royal Academy 1821–1842. Her maiden name was Dutton, and the first two awards were gained before her marriage. Died 1871.

Peart, Charles. Silver Medallion in 1783 for Modelling from the Life. *Sculptor.* Gold Medallist R.A. in 1782. Exhibited at Royal Academy 1778–1797.

Peters, Matthew William. Two Premiums in 1759 for Drawings. *Portrait and history painter.* R.A. Became a clergyman and abandoned painting, except as an amateur. Died 1814.

Pether, William. Premiums in 1756 for a Drawing, and for an Ornamental Design; in 1760 and 1767 for Mezzotints. *Mezzotint engraver.* Exhibited miniatures at Royal Academy 1781 to 1794, but "his true art was mezzotint," in which he "gained great distinction" (Redgrave). Died about 1794.

Physick, Edward Gustavus. Silver Medals in 1823 and 1824; Gold Medal in 1826 for Plaster Models. *Sculptor.* Exhibited at Royal Academy and elsewhere 1822–1868.

Physick, E. J. Silver Medal in 1846 for a Plaster Cast. Silver Medal in 1847 for a modelled figure. *Sculptor.*

Pinches, Thomas R. Silver Medals in 1836 and 1837 for Medal Dies. *Medallist.* One of the well-known family of London die-sinkers and medallists. "Cut many military, academical, and private medals" (Forrer). Amongst them was a memorial medal of the Duke of Wellington 1852.

Pine, Robert Edge. Premium in 1760 (100 guineas) for an Oil Painting, "The Surrender of Calais"; Premium (100 guineas) in 1763 for "Canute Rebuking his Courtiers." *History and portrait painter.* Exhibited at Royal Academy 1760–1784. Went to America. Died at Philadelphia 1790.

Pingo, Benjamin. Premiums in 1765, 1766 and 1769 for Drawings. Youngest son of Thomas Pingo.

Pingo, Henry. Premiums in 1756, 1758, 1759, 1760 and 1761 for Ornamental Designs. Second son of Thomas Pingo. Exhibited flower pictures at Free Society of Artists, 1772 and 1773.

Pingo, John. Premiums in 1759, 1760, 1762, 1763 and 1765 for Die Engraving. *Medallist.* Chief Engraver to the Mint. Eldest son of Thomas Pingo. Died 1830.

Pingo, Lewis. Premiums in 1756 and 1759 for Drawings; Premiums in 1759 and 1760 for Medallions; Premiums in 1757, 1758, 1760 and 1761 for Ornamental Designs; Premiums in 1761, 1763 and 1764 for Die Engraving; Premium in 1763 for Gem Engraving; Gilt Palette in 1770, Gold Palettes in 1771 and 1772 for Medallions. *Medallist.* Third son of Thomas Pingo. Engraver to the Mint. Died 1830.

Pingo, Mary. Premiums in 1758 and 1759 for Ornamental Designs; in 1761 and 1762 for Drawings of Flowers. Daughter of Thomas Pingo.

Pingo, Thomas, Paid 80 guineas in 1758 for making the dies for the Society's First Medal from a design by James Stuart, the Architect "Athenian Stuart." *Medallist.* Engraver to the Mint. Died 1776.

Pitts, William. Gold Medal in 1812 for a Wax Model. *Sculptor.* Exhibited at Royal Academy 1823–1839. Produced much successful work. Died 1840.

Pocock, William Fuller. Silver Medallion in 1807 for an Architectural Design. *Architect.* Exhibited at Royal Academy 1799–1827.

Porter, John Ashwood. Premium in 1755 for a Pen-and-Ink Drawing. He was the last of the five candidates who took the first prizes offered by the Society for young people under fourteen. He was the son of a drawing master in Wapping (Dossie), but nothing more seems to be known about him.

Porter, Robert Ker. Silver Palette in 1793 for an Historical Drawing. *History painter.* Sir Robert Porter, brother of Anne and Jane Porter, the novelists. "He was by turns, during his adventurous career, artist, soldier, author, and diplomatist" (Redgrave). Died 1842.

Poynter, Ambrose. Silver Medallion in 1818 for an Architectural Design. *Architect.* Father of Sir Edward Poynter, P.R.A. Exhibited at Royal

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Academy 1817-1852. Foundation Member of R.I.B.A., and its Secretary 1840, etc. Took important part in establishment of Schools of Design. "Had considerable practice as an architect" ("Dictionary of National Biography"). Died 1886.

Proctor, Thomas. Gold Palette in 1787 for an Historical Drawing. *Sculptor and History painter.* A brilliant but unfortunate genius. Gold Medallist R.A. 1784. Exhibited at Royal Academy 1785-1794. Died in misery and want 1794.

Pugh, Hubert. Premium in 1765 for a Landscape in Oil. *Landscape painter.* "There is a work of his in the Lock Hospital" (Redgrave). Died after 1788.

Pye, Charles. Silver Palette in 1791 for a Drawing. *Engraver.*

Radclyffe, George Edward. Silver Medal in 1824 for an Etching. Silver Palette in 1826 for an Engraving. *Engraver.* Worked for the Annuals and *Art Journal.* Died 1863.

Raimbach, Abraham. Gold Palette in 1806 for Wood Engraving. *Engraver.* Exhibited miniatures at Royal Academy 1797-1805, but afterwards devoted himself to engraving. Engraved many of Wilkie's pictures. Died 1843.

Ranson, Thomas Frazer. Silver Medal in 1814; Gold Medals in 1821 and 1822 for Engraving. *Engraver.* He was interested in the question of preventing the forgery of bank-notes, and barely escaped conviction for having a forged note in his possession.

Ravenet, Francois Simon. Premiums in 1761, 1762 and 1764 for Engravings. *Engraver.* A.R.A. Native of France. Came to England about 1750. Worked for Hogarth and Boydell. Engraved the "Mariage à la Mode." Died 1774.

Read, Nicholas. Premiums in 1762 (100 guineas) and in 1764 (140 guineas) for Statues. *Sculptor.* Pupil of Roubiliac, and his successor. Some monuments by him are in Westminster Abbey. Died 1787.

Read, Richard. Silver Palette in 1771 for a Drawing. *Engraver.* Worked chiefly in mezzotint.

Reinagle, Philip. Premium in 1767 for a Drawing. *Animal and landscape painter.* R.A. "His hunting pieces, sporting dogs, and dead game were excellent" (Redgrave). Died 1833.

Revel, Richard. Premium in 1755 for a Chalk Drawing of a Horse. This was the fifth prize in the class between fourteen and seventeen in the Society's first competition. Nothing seems to be known of his after career (Dossie).

Richardson, George. Premium in 1765 for an Architectural Drawing. *Architect.* Author of the "New Vitruvius Britannicus" and other works on architecture.

Rigaud, Stephen Francis. Silver Palette in 1794; Gold Palette in 1799 for Drawings. *Water-colour painter.* Exhibited at Royal Academy 1797-1815.

Roberts, James. Premium in 1766 for a Drawing. *Portrait painter.* Exhibited at Royal Academy 1773-1799.

Robertson, George. Premiums in 1760 and 1761 (three) for Drawings. *Landscape painter.* Pupil of Shipley. Went to Jamaica and painted views of the island, which were exhibited in London and engraved. Died 1788.

Rochard, Frederick. Silver medal in 1823 for a Water-colour Portrait. *Miniature painter.* Exhibited at Royal Academy from 1819. Died 1858.

Rogers, Philip Hutchins. Silver Medal in 1808 and Gold Medal in 1811 for Oil Paintings. *Marine and landscape painter.* Occasional Exhibitor at Royal Academy up to 1835. Died 1853.

Rolls, Charles. Silver Medal in 1818 for a Drawing. *Engraver and draughtsman.* Assisted the Findens in their "Gallery of British Art."

Romney, George. Premium in 1763 (20 guineas) for an Oil Painting of the Death of General Wolfe; Premium in 1765 (50 guineas) for Oil Painting of the Death of Edward the First. The celebrated *Portrait painter.* Died 1802.

Romney, John. Silver Palette in 1806 for Outline Drawing. *Engraver and draughtsman.* Engraved some of Smirke's illustrations to Shakespeare, etc. Died 1863.

Rooker, Michael Angelo. Premiums in 1759 for a Drawing (age under fourteen) and in 1760 for a Landscape. *Water-colour painter and engraver.* A.R.A. Died 1801.

Ross, William. Silver Palette in 1807 for a Drawing (at the age of twelve); Silver Medal in 1808 for a Drawing; Silver Palette in 1809 for a Miniature; Silver Medals in 1810 and 1811 for Drawings; Silver Palette in 1813 for a Drawing; Gold Medal in 1816 for a Portrait of the Duke of Norfolk; Gold Medal in 1817 for an Historical Painting. Sir William Ross, R.A., the well-known *Miniature painter.* He was Chairman of the Committee of Fine Arts 1845-6, and a Member of the first Council 1845 and 1846. An exhibition of his works was held by the Society in 1860. Died 1860.

Rossi, Charles. Premium in 1794 (50 guineas) for a Group of Statuary. *Sculptor.* R.A. Sculptor to George IV. and to William IV. Executed several monuments in St. Paul's Cathedral. Died 1839.

Rossi, Henry. Silver Medal in 1815 for copy of Plaster Cast. *Sculptor.* Designed terra-cotta ornaments for interior of St. Pancras Church.

Russell, John. Premiums in 1759 and 1760 for Drawings. *Portrait painter.* R.A. His best work was in crayons, and he published a book on "Painting with Crayons." Died 1806.

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Ryder, Thomas. Premium in 1766 for a Drawing; Gold Medal in 1803 for a Line Engraving. *Engraver and draughtsman.* "One of the best engravers of his time" (Redgrave). Executed eight plates for Boydell's Shakespeare Gallery. Died 1810.

Ryley, Charles Reuben. Premium in 1770 for a Drawing. *History painter.* Gold Medallist R.A. 1778. Exhibited at Royal Academy 1780–1798. Died 1798.

Samuel, George. Silver Medallion in 1784 for a View of the Front of the Society's House. *Landscape painter.* Exhibited at Royal Academy 1786–1823.

Samuel, Richard. Premium in 1773 for a Tool for Laying Mezzotint Grounds; Gold Palettes in 1777 and 1779 for Drawings. *Portrait Painter.* Exhibited at Royal Academy 1772–1779.

Sass, Henry. Silver Medal in 1807 for an Outline of the Laocoon. *Portrait painter and teacher.* According to Redgrave he was more successful in the latter capacity than in the first. Exhibited at Royal Academy 1808–1838. Died 1844.

Savage, William. Silver Medal in 1825 for "Block Printing in Colours in Imitation of Drawings." *Painter and engraver.* Experimented in printing in colour from wood blocks, and published a book on the subject in 1822.

Say, Frederick Richard. Silver Palette in 1817 for a Drawing; Silver Medal in 1819 for a Chalk Drawing; Silver Medal in 1820 for Crayon Drawings. *Portrait painter.* Exhibited at Royal Academy from 1825. Died probably about 1860.

Scharf, George. Silver Palette in 1835, and Silver Medal in 1836 for Drawings. Sir George Scharf, K.C.B., Keeper of the National Portrait Gallery. Died 1895.

Scheemakers, Thomas. Premiums in 1765 for Modelling in Clay, and in 1766 for a Bas-relief. *Sculptor.* Son of Peter Scheemakers, a Belgian sculptor who settled in London. Exhibited at Royal Academy 1765–1804. Died 1808.

Schiavonetti, Lewis. Silver Medal in 1807 for Engraving of the British Troops in the Bay of Aboukir. *Engraver.* Pupil of Bartolozzi. Died 1810.

Scott, John. Gold Medal in 1811 for two Original Engravings of Fox Hunting. *Engraver.* Successful as an engraver of animals. Died 1828.

Scoular, James. Premium in 1755 for a Drawing (at age of fourteen). *Miniature painter.* Exhibited at Royal Academy 1761–1787.

Scoular, William. Silver Medals in 1816 and 1819; Gold Medal in 1820; all for models. *Sculptor.* Gold Medallist R.A. 1817. Exhibited at Royal Academy 1815–1846.

Scriven, Edward. Gold Medal in 1813 for an Engraving of Gerard Douw; Gold Medal in 1815 for Engravings, after West. *Engraver.* Worked for Dilettanti Society, Shakespeare Gallery, etc., and was much employed by publishers. Died 1841.

Seddon, Thomas. Silver Medal in 1848 for Drawings of an Original Design for an Ornamental Carved Sideboard. He was the son of a cabinet maker. *Landscape painter.* Exhibited at Royal Academy 1852–1856. Died 1856. A collection of his works was shown at the Society in 1857, when an address was delivered by John Ruskin (*Journal*, Vol. V. p. 360).

Senefelder, Aloys. Gold Medal in 1819 for the Invention of Lithography. The process had been perfected in 1798, and lithographs had been published in England in 1801, but in 1818 Senefelder published his book on the subject.

Setchel, Sarah. Silver Palette in 1829 for a Pencil Drawing. *Water-colour painter.* Exhibited at Royal Academy 1831–1867. Gained great popularity by her picture, "The Momentous Question," engravings of which were hung in every print-shop. Died 1894.

Sharp, William. Premium in 1760 for a Drawing; Premiums in 1761, 1763 and 1764 for Designs. *Engraver.* "One of the most celebrated of English line engravers" (Bryan). Engraved West's portrait of Samuel More, the Society's Secretary. Died 1824.

Shelley, Samuel. Silver Palette in 1770 for a Figure Drawing. *Miniature Painter.* Exhibited at Royal Academy 1773–1808. Died 1808.

Shenton, Henry Chawner. Silver Medal in 1844 for a Clay Model of Sabina. *Sculptor.* Son of the engraver of the same name. Died 1846.

Sherlock, William. Premium in 1759 for a Figure Drawing; Premium in 1760 for an Engraving. *Portrait painter and engraver.* Exhibited at Royal Academy 1802–1806. Engraved portrait heads for Smollett's "History of England."

Sherwin, John Keyse. Silver Palette in 1769 for a Drawing; Premium in 1772 (50 guineas) for a Drawing; Premium in 1774 for an Engraving; Premium in 1775 for an Engraving; Gold Medal in 1778 for "Excellence in Engraving." The engraving (reproduced on page 732) for which the 1774 Premium was awarded was used for a vignette on the titlepage of the "Register of Premiums and Bounties" issued in 1778, and was reprinted as a frontispiece to the first volume of the *Transactions.* *Engraver and history painter.* Worked under Bartolozzi. Gold Medallist R.A. 1772 (for a Painting). "It is as an engraver that he will rank high among our artists" (Redgrave). Engraver to George III. Died 1790.

Sievier, Robert William. Silver Medal in 1812 for a Pen-and-Ink Drawing. *Engraver and sculptor.* After practising as an engraver for some years he devoted himself to sculpture. A man of varied accomplishments and of scientific tastes, he became an F.R.S. Died 1865.

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Simmons, William Henry. Silver Medal in 1833 for an Engraving. *Engraver.* "For many years perhaps the chief of English workers in his own line" (Bryan). Engraved after Landseer, Millais, Faed, Holman Hunt, Frith, Rosa Bonheur, and Hook. Died 1882.

Simpson, Philip. Silver Medal in 1822 for a Copy of a Portrait; Gold Medal in 1823 for a Portrait. *Portrait and subject painter.* Exhibited at the Royal Academy up to 1836.

Skelton, William. Silver Palettes in 1778 and 1779 for Drawings. *Engraver.* Published various works, including series of portraits of the family of George III. Died 1848.

Smart, John. Premiums in 1755 and 1756 (aged twelve) for Drawings; Premium in 1757 for a Portrait in Chalks of Shipley; Premium in 1758 for a Drawing. *Miniaturist.* Exhibited at Royal Academy 1770–1811. Spent some years in India. Died 1811.

Smirke, Robert. Silver Medallion in 1797 for Drawing of the Water-gate at York Buildings. Sir Robert Smirke. *Architect.* R.A. Died 1867.

Smith, Emma. Silver Palette in 1803 for an Historical Drawing. *Water-colour painter.* Exhibited at Royal Academy in 1805. She was a granddaughter of "Smith of Derby."

Smith, George. Premiums in 1760, 1761 and 1763 (50 guineas each) for Landscapes in Oil. *Landscape painter.* Known as "Smith of Chichester." "In his day they [his works] were lauded beyond their merits" (Redgrave), and he acquired considerable reputation and popularity. Died 1776.

Smith, Joachim. Premium in 1758 for a Medallion Model in Wax; Premium in 1761 for a Composition for Modelling Portraits in Miniature. *Modeller.* Dossie says that he practised his invention successfully for some years. Some of his models were reproduced by Wedgwood and by Tassie.

Smith, John. Premiums in 1760 and 1761 (25 guineas each); Premium in 1762 (50 guineas) for Landscapes in Oil. *Landscape painter.* Younger brother of George Smith, and not so good a painter. Died 1764.

Smith, J. Catterson. Silver Medal in 1825 for an Oil Painting. *Portrait painter.* President of the Royal Hibernian Academy. Died 1872.

Smith, Nathaniel. Premiums in 1758, 1761 and 1762 for Modelling Figures in Clay; Premiums in 1859 (two) for Drawings; Premium in 1760 for a Bas-relief. *Modeller.* Pupil of Roubiliac. Assistant to Nollekens.

Smith, Thomas. Premium in 1760 for an Engraved Gem. *Seal engraver.* No record of any later work of his has been found.

Solomon, Abraham. Silver Medal in 1838 for a Chalk Drawing from a Statue. *Subject painter.* Exhibited at Royal Academy 1843–1862. Died 1862.

Spang, Michael Henry. Premium in 1758 (30 guineas) for Modelling the "Seal of the Society used for Letters" designed by Cipriani and engraved by Kirk. *Modeller.* Carved the decorations on the Admiralty Screen, and the figures on the pediment of Spencer House. Died about 1767.

Spicer, Nehemiah. Premiums in 1762, 1763 and 1764; and a Gilt Palette in 1768 for Gem Engraving. No further record of his work has been found.

Spiller, John. Silver Palettes in 1778 and 1780 for Outline Drawings. *Sculptor.* Exhibited at Royal Academy 1778–1792. "The statue of King Charles, which stood in the centre of the piazza of the Royal Exchange, before the fire in 1838, was his work" (Redgrave). Died in 1794.

Spilsbury, John. Premiums in 1761, 1762 and 1763 for Mezzotints. *Mezzotint Engraver.* Engraved some of Reynolds's portraits. Drawing-master at Harrow about 1782.

Stannard, Mrs. Joseph. Gold Medal in 1828 for an Oil Painting. Wife of Joseph Stannard, a well-known landscape and marine painter of Norwich. Some members of the Stannard family designed for the Lowestoft Pottery works.

Staples, Robert. Premiums in 1763, 1764, 1765 and 1766 for Gem Engraving. He was a jeweller in Harp Court, Fleet Street. Nothing more seems to be known of his work.

Stevens, Edward. Premiums in 1762 and 1763 for Architectural Designs. *Architect.*. A.R.A. Pupil of Sir William Chambers. Died 1775.

Strange, Mary Bruce. Premiums in 1764 and 1765 for Drawings. Daughter of Sir Robert Strange, the eminent engraver.

Stubbs, James Henry Phillipson. Silver Medal in 1826 for an Etching; Silver Palette in 1828 for a Pen-and-Ink Drawing. *Engraver.* Pupil of the Findens. Produced book illustrations and some sporting plates. Died 1864.

Swaine, Francis. Premium in 1764 for a Sea-Piece. *Marine painter.* Two small paintings by him are at Hampton Court (Redgrave). Died 1782.

Swaine, John Barak. Silver Palette in 1831 for a Chalk Drawing; Silver Medal in 1833 for an Etching. Redgrave, under John Swaine, the father of J. B. Swaine, says he died in 1828, and Bryan follows him, but this seems to be a mistake. A John Barak Swaine exhibited in 1837 at the B. I.

Tallmache, William. Silver Medal in 1813 for a Bronze Cast. *Sculptor.* Gold Medallist R.A. 1805. "He does not appear to have followed up this success" (Redgrave).

Tassie, James. Premium in 1767 for "Figures, Heads, and Portraits of his composition resembling antique onyx." *Gem engraver.* Exhibited at

Royal Academy 1769-1791. Successful in reproduction of ancient engraved gems, and produced many fine originals. Died 1799.

Taylor, Isaac. Gold Palette (and 25 guineas) in 1791 for an Engraving of Opie's "Death of Rizzio." *Engraver*. Pupil of Bartolozzi. "Known chiefly by his works for Boydell's Shakespeare Gallery" (Redgrave). Died 1829.

Taylor, John. Premiums in 1761 and 1762 (two) for Drawings. *Portrait and subject painter*. Exhibited at Royal Academy 1779-1800. Died 1838.

Taylor, John. Premiums in 1763 and 1764 for Designs for Medals. Jeweller at Bath (Dossie).

Taylor, Simon. Premiums for Drawings in 1756, 1757, 1758 and 1759; Premiums in 1759 and 1761 for Pictures of Flowers; Premium in 1759 for an Etching. *Botanical draughtsman*. Pupil of Shipley. Employed by Lord Bute and by Dr. Fothergill. Died about 1798.

Theed, William. Silver Palette in 1820 and Silver Medal in 1822 for Copies of Statues. *Sculptor*. R.A. Settled in America, where he died 1850. The bust of the Prince Consort in the possession of the Society is the work of his son, also William Theed.

Tomkins, Charles. Silver Palette in 1776 for a View of Millbank. *Painter and engraver*. Son of William Tomkins, A.R.A. Exhibited at Royal Academy 1773-1779.

Tomkins, Peltro William. Silver Palette in 1780 for Landscape Drawing. Gold Medal in 1813 for method of refining ox-gall for artistic purposes. *Engraver*. Son of William Tomkins, A.R.A. Published various works, original and after other artists. Engraver to Queen Charlotte. Died 1840.

Tomkins, William. Premium in 1762 for a Landscape. *Landscape painter*. A.R.A. Also painted some pictures of dead game. Died 1792.

Toussaint, Auguste. Premium in 1766 and Silver Palette in 1768 for Drawings. *Miniature painter*. Exhibited at Royal Academy 1775-1788.

Towne, Francis. Premium in 1759 for a Design. *Landscape painter*. Exhibited at Royal Academy 1775-1810. Died 1816.

Towne, Joseph. Silver Medal in 1826 for a Model of a Skeleton; Gold Medal in 1827 for a Wax Model of the Brain. The skeleton is now in the museum of Guy's Hospital. He was seventeen when he constructed it, and it served as an introduction to Sir Astley Cooper, who at once put Towne in the way of obtaining employment. *Anatomical modeller*. Though self-taught, he was soon "engaged continuously in the practice of the art which he originated and brought to perfection, though it died with him" (D'Arcy Power, in the "Dictionary of National Biography"). He made over a thousand wax models of anatomical preparations, remarkable both for their verisimilitude, and for their artistic qualities. Towne was also a capable sculptor. Died 1879.

Turner, William. Silver Palette in 1793 for a Landscape Drawing. This may have been "Turner of Oxford," who exhibited as a water-colour landscape painter at Royal Academy, etc., for fifty-four years (Bryan), and died 1862.

Turnerelli, Edward. Silver Medal in 1833 for a Drawing. Son of Peter Turnerelli, a sculptor of reputation. Studied at Royal Academy. Achieved notoriety by collecting money for a gold laurel wreath for the Earl of Beaconsfield, which Lord Beaconsfield refused. Died 1890.

Twining, Elizabeth. Silver Medal in 1824 for a Water-colour painting of Flowers. *Amateur painter*. Philanthropist and Botanist. Daughter of Richard Twining. One of the Founders of Bedford College. Died 1889.

Tytler, George. Silver Medal in 1825 for a Lithographic Drawing. *Lithographer*. Published some views of Italian Scenery. Died 1859.

Underwood, Thomas. Silver Palette in 1828 for a Pencil Drawing of a Landscape. *Engraver and Writer on art and archæology*. Lived in Birmingham. Died 1882.

Vacher, Charles. Silver Medal in 1837 for a Lithograph. *Water-colour painter*. Died 1883.

Van Rymsdyk, Andries. Premiums in 1765 (at the age of eleven), 1766 and 1767 for Drawings; Premium in 1767 for a Mezzotint. Son of John van Rymsdyk, History painter.

Vendramini, Caroline. Silver Medal in 1821 for a Drawing. Daughter of Giovanni Vendramini.

Vendramini, Giovanni. Gold Medals in 1819 and 1829 for Engravings. *Engraver*. His reputation rested chiefly on his reproductions of the Old Masters. Died 1839.

Vendramini, R. Silver Palette in 1829; Silver Medals in 1830 and 1833 for Drawings. Daughter of Giovanni Vendramini. It is uncertain to which of the two sisters the 1829 and 1830 awards were made.

Vickers, Alfred Gomersal. Gold Medal in 1828 for a Marine Painting. *Marine, subject and landscape painter*. Exhibited at Royal Academy and elsewhere 1827-1837. Died 1837.

Vivares, Mary. Premiums in 1759 and 1761 for Drawings; Premium in 1763 for an Engraving. Daughter of Francis Vivares, the engraver.

Vivares, Thomas. Premiums in 1758 for an Ornamental Design; in 1760 for an Etching; in 1761 for a Drawing; in 1762 for an Etching; in 1763 for a Landscape; in 1764 and 1765 for Engravings; in 1766 for an Etching. *Engraver*. Son of Francis Vivares, the well-known engraver. Exhibited at Royal Academy 1783-1787.

Vulliamy, Benjamin. Premium in 1758 for a Drawing. He was a son of Justin Vulliamy, and the father of Benjamin (the second) and Lewis Vulliamy. Justin and the two Benjamins were eminent clock-makers. Benjamin the elder was

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favoured and consulted by George III. in connection with Kew Observatory, which was a hobby of the King. Died about 1820.

Vulliamy, Lewis. Silver Medal in 1813 for an Architectural Design. *Architect.* Gold Medallist, R.A. 1813. Exhibited at Royal Academy 1822–1838. Son of Benjamin Vulliamy the elder. Architect of many public buildings in London, and of numerous mansions, including Dorchester House, Park Lane. Died 1871.

Ward, Edward Matthew. Silver Palette in 1831 for "a copy in Indian ink of figures." *Historical painter.* R.A. From 1839, when he first exhibited at Royal Academy, his work was popular and successful. Painted several of the pictures in the corridor of the House of Commons. Died 1879.

Ward, Francis Swaine. Premium in 1765 for a Sea-piece. *Landscape painter.* Entered the service of the H.E.I.C. and went to Calcutta. Made numerous drawings of Indian temples, etc. Died about 1805.

Ward, John Raphael. Silver Medal in 1823 for a Water-colour Portrait (copy). *Engraver and copyist.* Produced miniature copies of some of Sir Thomas Lawrence's portraits. Son of James Ward, R.A. His daughter married E. M. Ward, R.A. Died 1879.

Ward, William. Silver Palette in 1805 for a Drawing of Ewell Church. *Mezzotint engraver.* A.R.A. Engraved many of the pictures of George Morland, whose sister he married. Died 1826.

Ward, William James. Silver Medals in 1813, 1814 and 1815 for Drawings. *Mezzotint engraver.* Son of William Ward, A.R.A. Engraver to the Duke of Clarence, afterwards William IV. Died 1840.

Waring, John B. Silver Medal in 1843 for an Architectural Design. *Architect.* Superintendent at 1862 Exhibition. Author of the three volumes on the Industrial Art and Sculpture of the Exhibition, and of other works on Art. Died 1875.

Warner, William. Gold Medal in 1827 for an Intaglio. *Seal engraver.* Started a business in London, which is still carried on by his son. Engraved seals for Queen Victoria. Died 1872.

Warren, Charles. Gold Medal in 1823 for Improvements in the Art of Engraving on Steel. *Engraver.* He had been employed in engraving for calico printing. Came to London in 1802 and was successful in book illustration. Chairman of Committee of Polite Arts, 1822. Died 1823.

Watson, John Burgess. Gold Medal in 1824 for a Design for a House; Silver Medal same year for a Drawing of a Crane. *Architect.* Died 1847.

Webber, Henry. Silver Palette in 1783 for an Historical Drawing. Gold Medallist R.A. in 1779 for a Group. As his address was "Etruria," he was presumably employed by Wedgwood.

Westall, William. Silver Palettes in 1798 for a Drawing; and in 1800 for a landscape. *Landscape painter.* He was draughtsman to Captain Flinders's voyage of Australian discovery, was wrecked, and had many adventures. Died 1850.

Wheatley, Francis. Premiums in 1762 and 1763 for Drawings; and in 1767 for a Landscape. *Landscape and subject painter.* R.A. Pupil of Shipley. Died 1801.

Wickstead, Philip. Premiums in 1763, 1764 and 1765 for Drawings. *Portrait painter.* Pupil of Zoffany. Went to Jamaica. Died before 1790.

Wilkins, Robert. Premiums in 1765 and 1766 for Sea-pieces. *Marine painter.* Exhibited at Royal Academy 1772–1779. Died about 1790.

Williams, Penry. Silver Medal in 1820 for a Landscape in Water-colour; Silver Medal in 1821 for a Chalk Drawing. *Landscape painter.* Exhibited at Royal Academy 1827–1869. Died 1885.

Williams, William. Premium in 1758 for a Drawing. *Subject and portrait painter.* Exhibited at Royal Academy 1770–1792.

Wilson, Andrew. Gold Medal in 1810 for Stereotype Printing. Some examples of his work are given in Vol. XXVIII. of the *Transactions*, p. 317.

Winkles, H. Silver Medal in 1820 for Pen-and-Ink Drawing of St. Mary's Abbey, York. *Architect.* Joint author (with B. Winkles) of works on the English and French Cathedrals.

Woollett, William. Premium in 1759 for a Drawing. *Engraver.* His "were the first English engravings that gained notice on the Continent." "His works gave a high character to the English school" (Redgrave). Died 1785.

Woolner, Thomas. Silver Medal in 1845 for "original modelled design, entitled 'Affection.'" *Sculptor.* R.A. Died 1892.

Wright, Richard. Premiums in 1766 and 1768 for Sea-pieces. *Marine painter.* His best-known work is his "British Fishery," engraved by Woollett. Died about 1775.

Wyatt, Henry. Silver Medal in 1812, and Silver Palette in 1813 for Drawings. *Portrait and subject painter.* Exhibited at Royal Academy after 1825. Died 1840.

Wyon, Anne. Silver Medal in 1821 for Modelling Wax Flowers. She was the wife of Thomas Wyon the elder, and the mother of Benjamin.

Wyon, Benjamin. Gold Medals in 1819 and 1821 for Medal Dies. *Seal engraver.* Chief engraver of seals. Son of Thomas Wyon the elder. Died 1858.

Wyon, James. Silver Medal in 1820 for a "Head in Miniature." *Die engraver.* Engraver at the Mint. Son of George Wyon, brother of Thomas Wyon the elder.

Wyon, Thomas, Junr. Gold Medals in 1810 and 1811 for Die Engraving. The award in 1810 was for a head of Isis, adopted for the Society's Isis Medal. *Medallist.* Son of Thomas Wyon the elder. Chief engraver to the Royal Mint. Died 1817.

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Wyon, William. Gold Medals in 1813, 1814 and 1820 for Medal Dies. *Medallist.* R.A. Chief engraver to the Mint. Nephew of Thomas Wyon the elder. The Medal in 1813 was for engraving the head of Ceres for the Society's Medal; that of 1820 was for designing and executing the dies for the "new large Medal of the Society," which he presented (see *Transactions*, Vol. XXXVIII. p. xxxiii.). Died 1851.

THE EXHIBITION OF BRITISH SILKS.

The Exhibition of British silken materials now being held at Prince's Skating Rink, Knightsbridge, which was opened by Her Royal Highness Princess Christian on June 5th, and visited by Her Majesty the Queen on the following day, is a most interesting and instructive one. It is the third exhibition held under the auspices of the Silk Association of Great Britain and Ireland, the first being in 1890, and the second four years later.

If judged only from the press notices of the Exhibition it might be supposed that the silk industry in this country had become extinct, but had recently been revived owing to the patriotic efforts of a few prominent advertising retail firms who deal in silks, and the work of subordinate branches of the Arts and Crafts and the Home Industries Associations. This is far from being the case, for the greatest portion of the exhibits have been made by firms which have been in the silk manufacturing trade for a century or more, and have been developing their businesses and improving the quality of their productions continuously in spite of the keen competition of foreign manufacturers, and the discouragements which often result from modern methods of trading and changes in political and social arrangements.

There can be little doubt that the chief reason why the firms which manufacture such goods as are shown at this Exhibition have been able to hold their own, and even improve their position, during the undeniably hard times which the trade has experienced, is because they have spared no efforts to improve the technical excellence, and the beauty and purity of their productions. It is quite probable that if the British silk manufacturers at the time of crisis, in the middle of the last century, had all adopted this policy in competing with their foreign rivals, there would have been, at any rate, less disaster attending the fiscal changes which enabled foreign manufacturers to flood the British market, as they did, with goods of better appearance but less intrinsic value than those of native manufacture.

This Exhibition therefore demonstrates, not the *revival* of the British silk industry, but its *survival*, improvement, and vitality.

The Exhibition, if studied in detail, provides an excellent object lesson of the evolution of the silken web from its source—the silk-producing moth—to its completion and final use by the dressmaker and furnisher. No better account, therefore, of this interesting show could be given than that afforded by noticing the exhibits which clearly show the salient points of this development.

At Stand No. 40 A, is an exhibit by Messrs. J. T. Brocklehurst & Sons, Ltd., of Macclesfield. This firm was founded in 1745, and now employs more than fifteen hundred workpeople in spinning, throwing, dyeing, winding and weaving silk. Their exhibit is a beautifully arranged collection of silk-moths, worms and cocoons, which have been bred and prepared by Mr. John Ball and his father, employees of the firm. Mr. Ball worthily keeps up the tradition of the operative silk weavers, many of whom were noted for their love of scientific recreations. The collection consists of specimens of a great many varieties of silk-producing moths, some being very large and gorgeous in colour. The most valuable, however, although the most inconspicuous in appearance, is the Bombyx Mori, the mulberry-feeding caterpillar of which genus is the Chinese silkworm. From this modest little domestic silkworm, the great bulk of silk, of incalculable value, used not only in China but wherever it has been used at all for thousands of years, has been obtained.

At Stand No. 1 A, Messrs. Durant, Bevan & Co., of London, show cocoons and reeled and thrown silk from China, Japan, Italy and India. A beautiful bundle of silk from the latter country should specially be noticed. India, if its silk industry were judiciously fostered, might become the successful rival of China as a silk producer. Messrs. G. H. Heath & Co., Macclesfield, Stand 42 B, also display skeins of thrown silk.

At Stand No. 7, Messrs. T. Clayton & Co., silk spinners of Halifax, show undyed samples of yarns of various sizes and twists, and at Stand No. 4, Messrs. Pearsall & Co., of London, exhibit silk yarns of all kinds, dyed in a great variety of beautiful colours, for which they have so great a reputation.

Undyed and undischarged, or grey, piece goods are also shown by Messrs. Clayton & Co. (Stand No. 7), and at Stand No. 2 (Mr. Webb), and Stand No. 6 (Mr. Chas. Hammond), may be seen dyed and cleaned, and re-dyed silk fabrics of all kinds.

Silk as used for embroidery is to be seen on several stands. Perhaps the most notable specimen is the cope worked by Miss Beatrice Cameron, of London (Stand 42 A), on the foundation of a gorgeous multi-coloured woven brocade.

The chief interest of the Exhibition centres, of course, in the hitherto unequalled display of woven silk fabrics. Of these, naturally those intended for furnishing purposes are the most numerous and attractive. The actual manufacturers exhibiting finished silk webs number eighteen, and the dealers, decorators, furnishers, drapers, dressmakers, etc., who have tastefully arranged exhibits showing silk fabrics in use, number thirty-three.

Messrs. Warner & Sons, of Newgate Street,

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London, and Braintree, Essex (Stands No. 38, 39, 40 and 70), undoubtedly show a collection of handwoven furniture and dress silks such as could not anywhere be surpassed, if indeed they could be equalled, for perfection of technique, beauty of colour and excellence and variety of design. This firm have also erected (Stand No. 25) one of their large Jacquard mounted hand-looms, on which a sturdy typical British weaver is making a wide damask web of green silk, shot with silver thread. This loom shows the highest perfection to which the loom for weaving rich silk fabrics has attained, and is a direct descendant of the ancient Chinese draw-loom. The system of interlacing threads on it, by means of which the web is constructed, is exactly similar to that invented and practised in ancient China, as well as in the East generally and in Europe since its introduction in mediæval times.

Messrs. Morris & Co., of London (Stand No. 13), have also a fine show of silk damasks and brocades woven at their Merton Abbey works, from designs by the distinguished founder of the firm who always aimed at and almost attained perfection in all that he undertook.

A small but scarcely less noteworthy collection of handwoven furniture silks is shown by the Gainsborough Silk Weaving Co., of Sudbury, Suffolk (Stand No. 60). The collection consists of figured velvets, damasks, brocades, brocatells, etc. These for the most part are close reproductions of ancient examples in design and texture.

Prominent amongst the numerous exhibitors of silk dress-goods are Messrs. Richard Atkinson & Co. (Stand No. 23). They are weavers of original Irish poplins, both plain and figured. These are made on hand-looms by a very large number of weavers at their factories in Dublin. Messrs. Pim Brothers & Co. (Stand No. 61), in addition to an excellent exhibit of poplin webs, show a model hand-loom, fitted up for weaving plain poplins, and also materials used in the manufacture of their goods in Ireland.

Messrs. Bailey, Fox & Co., of London, Plaistow in Essex, and Sudbury, Suffolk (Stand No. 29), have a good display of hand and power-loom woven silks and velvets. Some of their goods are still made on the hand-looms of Bethnal Green.

Other firms show silk dress-goods in great variety, made entirely on power-looms, but the space at disposal for this notice forbids reference to them in detail, as it does also of the many excellent and tasteful exhibits of the firms who buy and retail, or use silken fabrics for furnishing or dressmaking.

In conclusion, it may well be pointed out that the best way to encourage the silk weaving, as well as most other British industries, is to inquire for, and insist on having, goods which are not only beautiful in appearance but are well made, of honest unadulterated materials. Such a demand, if general, would undoubtedly be more effectual than the merely sentimental demand for British goods simply because they are British.

LUTHER HOOPER.

CORRESPONDENCE.

THE MANUFACTURE OF NITRATES FROM THE ATMOSPHERE.

The following figures and remarks on the general nitrogen situation, in amplification of some statistics given by Mr. Kilburn Scott, may be of interest:—

ADDITION TO TABLE I. ON PAGE 646 OF THE *Journal* (completing the record from 1906 to 1912).

Production of Sulphate of Ammonia in the United Kingdom.	1911.	1908.	1907.
Gasworks	169,500	165,000	165,000
Ironworks	20,000	18,000	21,000
Shaleworks	60,000	53,500	51,000
Coke ovens and producer-gas plants	129,000	85,000	75,500
Total . .	378,500	321,500	312,500

It should be noted that the above figures only apply to the production in the United Kingdom, and that in 1906 some 69 per cent. of the output of these islands was exported, while the ratio of export has gradually increased to 78 per cent. in 1911; so that the home consumption, which was in 1906 about 89,700 tons, was only some 83,250 tons in 1911—that is, had actually decreased in the period by over 7 per cent.

The figures of the home output and consumption, however, furnish no idea of the world's production, which for certain years I am able to estimate as follows. It should be noticed that, as each year's output is pretty well consumed, the stocks held in the various countries do not count:—

WORLD'S OUTPUT OF SULPHATE OF AMMONIA.

1860	10,000 tons
1902	545,000 ,,
1907	845,000 ,,
1909	1,000,000 ,,
1911	1,210,000 ,,

The table given on page 757, which shows the consumption of nitrate of soda in the principal countries of the world for comparison with Table II. of Mr. Scott's lecture, will be of interest. The data are derived from the "Engrais."

Comparing the consumption of Chili nitrate in the United Kingdom with the consumption of sulphate of ammonia, we find that whereas in the latter the consumption has fallen off some 7 per cent., the former has from 1906 to 1911 increased some 20 per cent.

Even a cursory glance at the tables of the world's production, and the consumption in various countries of nitrogenous fertilisers, shows that the production of sulphate of ammonia in the United Kingdom is increasing at a much lower ratio than it is elsewhere, and that the consumption is either stationary or decreasing; while the consumption of nitrate of soda, though increasing on an average 4 per cent. per annum, is not nearly so active as

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Consumption of Nitrate of Soda in Various Countries.

	1906.	1907.	1908.	1909.	1910.	1911.
Germany	559,040	545,900	614,000	666,400	746,640	717,760
France	216,200	231,500	269,900	261,190	319,880	327,110
England	106,950	111,020	205,000	110,610	120,870	128,380
Holland	120,640	136,070	121,000	99,090	132,740	139,700
Belgium	178,100	164,600	205,000	233,870	272,960	202,460
Italy	46,620	41,940	45,000	52,390	43,370	51,780
Austria-Hungary	6,880	6,120	7,620	12,180	5,590	5,100
Spain	4,670	5,820	6,950	15,990	10,490	8,670
Sweden	5,320	5,370	2,000	—	2,400	2,290
Denmark	—	2,360	—	—	—	3,320
Egypt	—	—	—	—	—	25,680
United States	355,000	355,000	310,000	410,000	502,000	551,000
Other Extra European States	38,000	43,000	46,000	56,000	83,000	77,000
Unsold Stocks held at end of year	2,580	23,300	137,530	190,880	68,280	180,150
Total Exports from Chili	1,640,000	1,672,000	1,970,000	2,108,600	2,308,200	2,420,400

either in Germany, France, or the United States, where the average rate of increase per cent. per annum has amounted to 5·6, 9·3 and 11·6, respectively, in the period between 1906 and 1912. Probably to a considerable extent the comparatively slower rate of increase in the agricultural demand for nitrogenous fertilisers in this country, is due to having started the use of artificials at a relatively higher stage of manuring than the three other countries. Owing to the countryside here being more plentifully provided with stock than was the case there, it does not require nearly as much artificial manure. Some of the discrepancy may also, no doubt, be accounted for by the fact that relatively more of the nitrogenous material is used up in manufactures there than in the United Kingdom.

There can be no doubt, however, that it would be better for British agriculture if increasingly larger amounts of artificials were used, or in other words if more intensive cultivation were practised, as more advantage would be taken of our natural advantages of soil and climate, than our farmers at present see their way to.

Here is an opportunity for the new manures, "nitrolim" (calcium cyanamide) and nitrate of lime, to establish themselves, which they could not hope for were the field more efficiently occupied by older competitors. The farmer must progress at a much higher rate of acceleration in the use of nitrogenous fertilisers, if he is to hold his own against the competition of the foreign-grown produce with which we are increasingly flooded year by year. Also the chemical manufacturer, who is in an analogous position, must gird his loins and become a far greater consumer of the raw material with a nitrogen basis than he has been in the past, if he means to hold his own in the world of chemical products. Patriotism should have something to say in the matter also, as Sir William Ramsay and your lecturer both very pertinently pointed out.

Henry E. P. Cottrell.

I beg to thank you for forwarding me the *Journal* of the Society of May 17th. I think the following points may perhaps be of interest to your readers.

With reference to the comparison of the Schönherr furnace with the Eyde-Birkeland furnace, the impression is conveyed by the paper that the Schönherr furnace is more expensive than the other. This is, in my opinion, not the case; and, moreover, in any comparison of the two processes, the important fact must be borne in mind that the Schönherr furnace delivers the gases richer in nitrogen oxides, than does the Eyde-Birkeland furnace. Consequently, for the same output of lime-saltpetre, a smaller absorption plant is necessary when using Schönherr furnaces than when using the Eyde-Birkeland furnace.

The pictures given on page 653 of the *Journal* are, in a way, misleading; some mistake has occurred. The first print, given quite correctly, shows one of the eight rows of twelve Schönherr

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furnaces as they are set up at Rjukan; the lower one, Fig. 7, is entitled "Rjukan Saltpetre Factory, View of Furnace Room showing twelve Eyde-Birkeland Furnaces." This is a mistake; the print is from a photograph of the Notodden factory, and the twelve furnaces shown are the small type of the Eyde-Birkeland furnace, not the large type utilising 3,000 kilowatts, of which there are not twelve set up at Rjukan. Eighty per cent. of the energy developed at the Rjukan factory is employed in Schönherr furnaces, and 20 per cent. in the Eyde-Birkeland furnaces.

I should like to be permitted to deal with two points raised by the Chairman, Sir William Ramsay, at the discussion. He refers there to a patent of Professor Guye, taken out "about 1898," and expresses the view that the Schönherr furnace is simply a modification of Professor Guye's invention, and that he had difficulty in understanding how patents came to be granted to Schönherr, unless, indeed, they were merely for improvements or modifications of Professor Guye's invention.

I am quite at a loss to understand these comments. No patent at all of Professor Guye that bears any resemblance whatever to the Schönherr patents is known to me, and the date "about 1898," mentioned by Sir William Ramsay, gives no assistance in finding any such patent. Again, in none of the countries in the world where patent applications are subjected to examination before they are granted, has any patent of Professor Guye's been cited against the Schönherr patents for the long stable electric arc. These latter contain the statement that this long stable electric arc is an entirely new phenomenon hitherto unknown either in nature or in the arts; this statement has already stood the test of litigation, in some cases its truth has been admitted; in one, where it was contested, the decision was in favour of the Schönherr patent on that point and every other.

Further, Professor Guye delivered an exhaustive lecture on "La Fixation Industrielle de l'Azote," before the Société chimique de France, on May 24th, 1909. He dealt with his own work, and with the furnaces of Schönherr and others, and made no such claim as that put forward by Sir William.

Sir William Ramsay is also represented as saying that the nitrate of calcium originally manufactured could not be handled, as it turned wet when exposed to the air. Dr. Messel suggested making a basic calcium nitrate, and made a free gift of this suggestion to the Norwegian company; without such aid the product would have been totally unworkable, as it absorbed moisture as quickly as chloride of calcium does.

I recollect that about four years ago Dr. Messel, in the discussion of a paper by Mr. Eyde, did suggest the manufacture of basic nitrate of lime instead of neutral nitrate. I do not know if this is the suggestion to which Sir William Ramsay referred, but in any case there is great confusion as to the facts. The product manufactured to-day is not the basic nitrate of lime, but the neutral nitrate, just as it was long before the suggestion of Dr. Messel that I refer to. The commercial product was originally neutral nitrate of lime, and is so to this day. Experiments have of course been made with basic nitrate, but they have been, so far, unsuccessful.

Thanking you again for your courtesy in giving me the opportunity of taking part in this discussion.

ERNEST F. EHRHARDT.

Ludwigshafen a/Rh.

Je vous remercie de l'aimable communication de l'article de M. Ern. Kilburn Scott, contenue dans votre numéro du 17 mai, 1912; j'en ai pris connaissance avec grand intérêt.

Il est difficile pour une personne qui n'a pas pris part à une discussion d'y intervenir après coup; néanmoins, je me permettrai de vous donner les quelques indications suivantes:

Nos premiers brevets, sur lesquels Sir William Ramsay a attiré l'attention, datent du 15 juillet 1895 (D.R.P.), et non pas de 1898 ainsi que cela a été imprimé par erreur; ces brevets résultent de travaux que j'ai effectués avec la collaboration du Professeur C. E. Guye et de M. Aloys Naville et dont on trouvera l'historique dans un rapport récent de la Société d'Encouragement ("Bulletin de la Société d'Encouragement pour l'Industrie Nationale," Paris, février 1911). C'est dans nos brevets de 1895–96 que sont formulés les principes suivants appliqués depuis par la plupart des constructeurs:

"Pour obtenir le meilleur rendement possible en oxyde d'azote par rapport à l'énergie électrique consommée, il est indispensable, toutes choses égales d'ailleurs: 1°) de soustraire rapidement les gaz à l'action des décharges électriques avant d'atteindre la teneur limite en oxydes d'azote; 2°) de renouveler constamment et rapidement les gaz soumis à l'action de ces décharges; 3°) de donner à la chambre d'oxydation une forme aussi rétrécie que possible par rapport à l'espace où se produit les décharges électriques, de façon à soumettre la masse totale du gaz à l'action des hautes températures produites par ces décharges."

Dès l'année 1903 nous obtenions à Genève, à la suite d'une véritable marche industrielle de 6,000 heures de jour et de nuit, une demi-tonne environ d'acide nitrique aqueux à 40% NO_3H; les appareils présentant une sécurité de marche assez grande pour ne demander aucune surveillance pendant leur fonctionnement de nuit.

Des échantillons de l'acide brut ainsi obtenu et des échantillons d'acide redistillé furent envoyés à quelques fabriques; voici à titre de curiosité le résultat de l'analyse qui en fut faite à Ludwigshafen, en 1903, dans les laboratoires de la Badische Anilin & Soda Fabrik, sur les ordres de M. le Dr. G. Brunck, à l'obligeance duquel je dois les chiffres suivants:

Le produit brut, recueilli dans les appareils en grès, contenait 39·6% HNO_3, 0·2% HNO_2 et un peu

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d'acide chlorhydrique et d'acide sulfurique, ces deux derniers provenant du matériel en grès et des joints au sulfate de baryte et au silicate de sodium. Le produit distillé contenait 46·7% HNO_3, 0·02 HNO_2, des traces de HCl et pas de H_2SO_4.

Pour tous les détails techniques relatifs à nos procédés qui ont été mis en œuvre à Genève au moyen de fours de 200 et 400 kw., je me borne à citer ici les conférences détaillées que j'ai données sur ce sujet, en 1906, devant la "Society of Chemical Industry" à Londres, en 1909, devant la "Société chimique de France," à Paris, et en 1910 devant la "Société d'Encouragement pour l'Industrie Nationale," à Paris. La seule particularité nouvelle sur laquelle il me paraisse utile d'attirer ici l'attention, concerne un procédé, étudié avec la collaboration de MM. les Drs. Darier et van Vloten, qui permet de transformer directement le chlorure de sodium en nitrate de sodium, sans perte d'acide nitrique.

En ce qui concerne l'avenir économique des procédés industriels pour la fixation de l'azote, il est certain que ceux-ci sont appelés à se développer en Europe, ainsi qu'on peut d'ailleurs le constater par les statistiques intéressantes publiées par M. Scott. Je crois néanmoins que les usines électrochimiques susceptibles de produire les quantités colossales d'engrais azotés qui seront indispensables dans l'avenir pour l'agriculture (la consommation mondiale du nitrate du Chili et de sulfate d'ammoniaque dépasse déjà trois millions de tonnes par an, et augmente chaque année d'environ de 10% sur la consommation de l'année précédente) s'établiront nécessairement dans les régions des grands fleuves: Amérique du Sud, Indes, Afrique. En particulier, il convient de porter son attention sur les grands fleuves du plateau africain, qui parviennent presque tous à la mer par des rapides présentant souvent, sur des distances relativement courtes, des différences d'altitude de 3 à 4 cents mètres. Ces conditions, jointes au débit d'eau énorme de ces cours d'eau, sont éminemment favorables à l'établissement d'installations hydro-électriques très avantageuses, en ce sens que par la captation d'une seule chute, il est aisé d'obtenir une puissance d'un demi-million de HP, tandis qu'en Europe la captation d'une seule chute donne rarement plus de 20,000 HP.

Les pays qui possèdent, comme la Grande Bretagne, de pareilles richesses naturelles, ont ainsi une occasion exceptionnelle de les mettre en valeur; les opérations de ce genre paraissent d'autant moins hasardeuses que les quantités d'azote fertilisant réclamées chaque année par l'agriculture sont si considérables que pour suffire seulement à l'augmentation actuelle de la consommation mondiale en nitrate de soude, soit environ 200,000 tonnes par an, il faudrait équiper chaque année des forces motrices représentant une puissance totale de 400,000 HP. environ. C'est une entreprise que peuvent seuls faire les pays qui disposent de capitaux considérables, car en comptant 500 francs par HP.-équipé, le capital nécessaire pour installer les usines hydro-électriques et les installations électrochimiques nécessaires pour la fixation de l'azote, on voit qu'il faudrait immobiliser chaque année une somme de francs 200,000,000 — soit £8,000,000.

Veuillez agréer, cher Monsieur, l'assurance de ma considération très distinguée.

Genève. PH. A. GUYE.

I do not know the date of Schönherr's patents, not having studied them, but I do know that in 1905 or 1906 I saw at Geneva high tubes, fitted with a perfectly stable arc, bearing, so far as I remember, a very close resemblance to the diagram of Schönherr's apparatus given by Mr. Kilburn Scott.

Professor Guye has dealt with the subject of the original patents, so that I need not allude to them. WILLIAM RAMSAY.

GENERAL NOTES.

THE OPTICAL CONVENTION.—In connection with the sitting of the Optical Convention, which opens on the 19th inst., an exhibition of optical and allied instruments will be held in the eastern portion of the Southern Galleries of the Science Galleries of the Science Museum at South Kensington. The Exhibition will be distributed into three departments: (1) The Trade Exhibition.—In this collection British optical manufactures will be found to be very fully represented. The exhibiting section of the trade will include nearly all the leading manufacturers of optical instruments and apparatus in the United Kingdom; (2) the Loan Collection.—The loan collection will comprise some extremely interesting instruments from the historical point of view, and also a considerable number of instruments of special scientific interest. In addition to these, a temporary library will be formed by a collection of volumes bearing upon optics, lent by the leading publishers and scientific societies. In connection with the library, it may be mentioned that members will find the admirably-appointed science library accessible in an adjacent part of the Science Museum, and the equally well-equipped art library of the Victoria and Albert Museum on the other side of Exhibition Road. In connection with the loan collection, it is appropriate to say that the Science Museum collection of optical instruments will be easily accessible to members attending the Convention, since it is contained in the adjacent West Galleries of the Science Museum; (3) Demonstrations.—The large room beyond the reception room in the members' annexe, will be devoted to diagrams and apparatus to be used in illustration of the papers to be read. In addition to this, there will be a public demonstration room on the first floor, in which from time to time the exhibitors of instruments and apparatus of special interest will give public demonstrations. These demonstrations will often be arranged at short notice, and by private communication, so that visitors to the Exhibition interested in the particular examination of any special instrument may make arrangements

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with the exhibitors for such demonstrations at mutually convenient times. A third form of demonstration, which will be arranged in connection with the Exhibition, consists in the reproduction of certain historical experiments, which have contributed notably to the development of the science of optics. A room, to be called the "Isaac Newton" room, will be fitted up with apparatus constructed in accordance with the description given by Newton in his "Opticks," of the apparatus which he himself used in some of the principal experiments described in that work. This apparatus will be so fitted up that the experiments described by Newton may be repeated with this *facsimile* apparatus; and, with a powerful arc lamp to replace the sun, it will be possible to repeat Newton's demonstrations at all times of the day, and under all conditions of weather. The preparation and care of this exhibit have been taken in hand by Professor Silvanus P. Thompson. Further particulars of the papers to be read, etc., will be found below, under the heading "Meetings for the Ensuing Week."

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.—The fourth annual report of the governing body of the Imperial College of Science and Technology shows that the total number of students during the year 1910–12 was 887, as compared with 788 for the previous session. The number of students attending post-graduates has been steadily increasing from 30 in 1907–08 to 136 last year. A statement recently prepared shows that 24 per cent. of the students were born in London, 45 per cent. in England (other than London), 7 per cent. in Scotland, Ireland and Wales, 13 per cent. in the British Colonies and Dependencies, and 11 per cent. in foreign countries. The report also contains some account of the research work which is being conducted in the various departments of the College.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 17...Victoria Institute, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir Andrew Wingate, "Modern Unrest and the Bible."

Chemical Industry (London Section), at the Chemical Society's Rooms, Burlington House, Piccadilly, 8 p.m. 1. Mr. W. H. Perkin, "The Production and Polymerisation of Isoprene and its Homologues." 2. Mr. W. J. Dibdin, "A Hand Photometer." 3. Messrs. J. Newton Friend and W. J. Davison, "The Oxidation of the Drying Oils."

TUESDAY, JUNE 18...Statistical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. A. L. Bowley, "The Measurement of Employment—an Experiment."

Society of Painters in Tempera, Crosby Hall, Cheyne-walk, Chelsea, S.W., 8.15 p.m. Professor Selwyn Image, "The Future of Mural Decoration."

WEDNESDAY, JUNE 19...Optical Convention, Imperial College of Science, South Kensington, S.W., 8 p.m. 1. Presidential Address. 2. Conversazione.

Geological, Burlington House, W., 8 p.m.

Microscopical, 20, Hanover-square, 8 p.m. 1. Lord Avebury, "Notes on Pollen." 2. Dr. J. F. Gaskell, "Demonstration of a Method of obtaining Frozen Sections after embedding in Gelatin." 3. Messrs. Heron-Allen and Mr. A. Earland, "On some new Astrorhizidae and their Structure."

Meteorological Society, 70, Victoria-street, S.W., 4.30 p.m. 1. Mr. W. W. Bryant, "The Adoption of a Climatological Day." 2. Mr. A. P. Jenkin, "A Three-Year Period in Rainfall."

THURSDAY, JUNE 20—Optical Convention, Imperial College of Science, South Kensington, S.W., 10 a.m. 1. Mr. J. Rheinberg, "The Micro-Spectra Method of Natural Colour Photography." 2. Mr. C. F. Lan Davis, "Sector Shutters." 3. Mr. R. W. Cheshire "The Transmission of Visible Light through Photographic Lenses." 4. Mr. P. Everitt, "On the Principal Surfaces of a Lens." 5. Paper by Mr. T. Smith.

8 p.m. Public Lecture by Professor Stirling, "Some Optical Illusions."

Antiquaries, Burlington House, W., 8.30 p.m.

Linnean, Burlington House, W., 8 p.m. 1. Señor Ignacio Bolivar, "Les Euorthoptères des Seychelles." 2. Mr. C. G. Lamb, "Diptera: Loncheidæ, etc., of the Seychelles." 3. Mr. Hugh Scott, "The Coleoptera of the Seychelles." 4. The late Dr. G. Budde-Lund, "Terrestrial Isopoda, particularly considered in relation to the Distribution of the Southern Indo-Pacific Species." (These four papers form part of the reports of the Percy Sladen Expedition.) 5. Mr. H. Stuart Thompson, "Selection of coloured drawings of Alpine Flowers by Mr. George Flemwell." 6. Miss Nellie Bancroft, "On some Indian Jurassic Gymnosperms." 7. Mr. Carl Christensen, "The Ferns of the Seychelles and Aldabra."

Chemical, Burlington House, W., 8.30 p.m. 1. Sir William Ramsay, "The Formation of Neon as a Product of Radioactive Change." 2. Mr. S. U. Pickering, "The Colour Intensity of Copper Salts." 3. Messrs. P. C. Ray, N. Dhar, and T. De, "Nitrites of the Mercurialkyl- and Mercurialkylaryl-ammonium Series." (Part II.) 4. Mr. I. Masson and Sir William Ramsay, "An Analysis of the Waters of the Thermal Springs of Bath." 5. Messrs. H. J. H. Fenton and W. A. R. Wilks, "Studies on certain Aliphatic Hydroxy-acids." 6. Mr. J. Kenner, "Formation of Seven- and Eight-membered Rings from 2 : 2¹-ditolyl." 7. Messrs. W. H. Glover and T. M. Lowry, "Studies of Dynamic Isomerism. Part XIII.—Camphocarboxamide and Camphocarboxypiperidide. An illustration of Barlow and Pope's Hypothesis." 8. Messrs. T. M. Lowry and W. H. Glover, "Studies of Dynamic Isomerism. Part XIV.—Successive Isomeric Changes in Camphocarboxamide and Camphocarboxypiperidide." 9. Messrs. G. G. Henderson and W. Caw, "Contributions to the Chemistry of the Terpenes. Part XIII.—The Preparation of Pure Bornylene."

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. B. K. Henderson, "The History of the Commonwealth Charters to the Towns."

FRIDAY, JUNE 21...Optical Convention, Imperial College of Science, South Kensington, S.W., 10 a.m. Joint Meeting with the Physical Society. 1. Dr. G. F. C. Searle, "Demonstration of Apparatus for the Teaching of Optics." 2. Mr. J. W. Gordon, "Diffraction Patterns." 3. Mr. E. H. Rayner, "The Shape of Scales required for Reflecting Instruments with Concave Mirrors." 4. Messrs. C. C. Patterson and B. P. Dudding, "The Visibility of Distant Lights." 5. Dr. T. M. Lowry, "Some Points in the Use and Design of Refractometers." 6. Messrs. J. S. Dow and V. H. Mackinney, "Recent Advances in the Measurement of Light and Illumination."

8 p.m. 1. Professor S. P. Thompson, "The Trend of Geometrical Optics." 2. Messrs. A. C. Jolley and A. J. Bull, "The Measurement of Colour." 3. Dr. J. A. Harker, "Optical Pyrometry."

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Journal of the Royal Society of Arts.

No. 3,109. VOL. LX.

FRIDAY, JUNE 21, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

FINANCIAL STATEMENT FOR 1911-12.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31st, 1912.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts & Co., May 31st, 1911 (including £423 to be re-invested)				3,696	8	8
,, Subscriptions	5,156	11	0			
,, Life compositions	504	0	0			
				5,660	11	0
,, Dividends and Interest				671	4	5
,, Ground Rents				646	15	7
,, Examination Fees				4,174	17	9
,, Conversazione, 1911 (Sale of Tickets)				32	15	0
,, Advertisements				471	18	9
,, Sales, etc.:—						
Cantor Lectures	13	17	0			
Examination Programmes	49	8	4			
Fees for use of meeting-rooms	72	19	6			
Journal	131	1	6			
Leather Committee Reports	9	15	9			
				277	2	1
,, Donation to Examination Prize Fund:—						
Clothworkers' Company				30	0	0
				£15,661	13	3

Cr.

	£	s.	d.	£	s.	d.
By House:—						
Rent, Rates, and Taxes	847	4	1			
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	291	12	6			
Repairs and Alterations	48	2	9			
				1,186	19	4
,, Office:—						
Salaries and wages	2,546	11	9			
Stationery, Office Printing and Lithography	492	18	1			
Advertising	65	4	0			
Postage Stamps, Messengers' Fares, and Parcels	287	8	11			
				3,392	2	9
,, Library, Bookbinding, etc.				97	11	8
,, Conversazione (1911)				274	5	11
,, **Journal*, including Printing and Publishing				2,139	0	2
,, *Advertisements (Agents and Printing)				237	8	6
,, Examinations				4,103	0	2
,, Medals:—						
Albert	21	0	0			
Society's	89	3	6			
				110	3	6
,, Owen Jones Prizes				18	12	0
,, Fothergill Prize				43	3	0
,, North London Trust				4	0	0
,, Howard Lectures				40	0	0
,, Juvenile Lectures				22	5	0
,, Cantor Lectures				188	14	9
,, Publication of "Industrial England"				10	14	2
,, Repairs to Wm. Shipley's Tomb				7	19	6
,, Sections:—						
Colonial	44	16	4			
Indian	77	18	8			
				122	15	0
,, Committees (General Expenses)				20	6	5
,, Re-investment of Owen Jones Trust in India 3 per Cent. Stock				423	0	0
				12,445	1	10
,, Cash in hands of Messrs. Coutts & Co., May 31st, 1912				3,216	11	5
				£15,661	13	3

* Payments for thirteen months.

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Liabilities.

	£	s.	d.	£	s.	d.
To Sundry Creditors	794	3	1			
,, Examiners' Fees	1,369	6	6			
,, Examination Prizes and Medals	185	0	0			
,, Sections :—Colonial and Indian	100	0	0			
,, Accumulations under Trusts	408	1	7			
				2,856	11	2
,, Excess of assets over liabilities				25,203	17	11
				£28,060	9	1

Assets.

	Amount of Stock, etc. £	s.	d.	Worth on May 31st, 1912. £	s.	d.	£	s.	d.
By Society's Accumulated Funds invested as follows :									
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0	2,910	0	0			
Canada 3½ per Cent. Stock	500	0	0	485	0	0			
South Australia 4 per Cent. Stock	500	0	0	505	0	0			
N.S. Wales 3½ per Cent. Stock	530	10	1	517	5	0			
N.S. Wales 4 per Cent. Stock	500	0	0	527	10	0			
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217	0	0	228	18	7			
Queensland 4 per Cent. Bonds	1,500	0	0	1,530	0	0			
Natal 4 per Cent. Stock	500	0	0	525	0	0			
Ground-rents (amount invested)	10,496	2	9	10,496	2	9			
Metropolitan Water Board B. Stock	321	15	9	265	9	6			
New River Co. shares	6	0	0	6	0	0			
India 3½ per Cent. Stock	3,408	14	6	3,161	11	10			
	21,480	3	1				21,157	17	8
,, Subscriptions of the year uncollected				689	0	0			
,, Arrears, estimated as recoverable				306	0	0			
							995	0	0
,, Property of the Society (Books, Pictures, etc.)							2,000	0	0
,, Advertisements due							291	0	0
,, Cash in hands of Messrs. Coutts & Co., May 31st, 1912							3,216	11	5
,, Do. on Deposit (against interest on Trusts)							400	0	0
							£28,060	9	1

Funds held in Trust by the Society.

	£	s.	d.	
Dr. Swiney's Bequest	£4,477	10	0	Ground-rents, chargeable with a sum of £200 once in five years.
John Stock Trust	100	0	0	Consols, chargeable with the Award of a Medal.
Benjamin Shaw Trust for Industrial Hygiene	133	6	8	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	192	2	1	,, ,, ,, ,,
Fothergill Trust	388	1	4	,, ,, ,, of a Medal.
J. Murray and others, in aid of a Building Fund	75	14	4	,, £54 18*s*. 0*d*. and India 3½ per Cent. Stock £20 16*s*. 4*d*.
Subscriptions to an Endowment Fund	562	2	2	,,
Dr. Aldred's Bequests	220	2	3	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	571	0	0	Metropolitan Railway 3½ per Cent. Preference Stock, chargeable with the Award of a Prize.
Dr. Cantor's Bequest	648	19	7	Bombay and Baroda Railway Guaranteed 3 per Cent. Stock — Interest applied to the Cantor Lectures.
	3,273	16	6	India 3 per Cent. Stock
	2,695	11	3	Ground-rents
Owen Jones Memorial Trust	522	3	2	India 3 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Francis Cobb Fund	255	14	1	New South Wales 3½ per Cent. Stock.
Amount to cover accumulated Interest on Trust Funds	400	0	0	On deposit with Messrs. Coutts & Co.
	£16,574	19	5	

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TOTAL OF INVESTMENTS, ETC. (FACE VALUE), STANDING IN THE NAME OF THE SOCIETY (INCLUDING SOCIETY'S ACCUMULATED FUNDS AND TRUSTS AS ABOVE).

Ground-rents (amount of cash invested)	£17,669	4	0
Consols	1,650	12	6
Metropolitan Railway 3½ per Cent. Preference Stock	571	0	0
Bombay and Baroda Railway Guaranteed 3 per Cent. Stock	648	19	7
India 3 per Cent. Stock	3,795	19	8
India 3½ per Cent. Stock	3,429	10	10
Canada 3½ per Cent. Stock	500	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	786	4	2
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Bonds	1,500	0	0
Natal 4 per Cent. Stock	500	0	0
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0
Metropolitan Water Board B. Stock	321	15	9
New River Company Shares	6	0	0
Cash on Deposit with Messrs. Coutts & Co.	400	0	0

Society's Accumulated Funds	21,480	3	1	£38,055 2 6
Trust Funds held by Society	16,574	19	5	

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts & Co., as above set forth, have been duly verified.

JOHN M. THOMSON }
CARMICHAEL THOMAS } *Treasurers.*

H. T. WOOD, *Secretary.* KNOX, CROPPER & Co., *Auditors.*

Society's House, Adelphi, 12th June, 1912.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Fifty-Eighth Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the By-laws, on Wednesday, June 26th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary.*

NORTH LONDON EXHIBITION TRUST.

In 1865 the Committee of the North London Working-classes and Industrial Exhibition (1864) presented to the Society of Arts a sum of £157, the balance of the surplus from that Exhibition, with a view to the annual award of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society of Arts. The Art Workmanship Competitions were discontinued after 1870, but since that date various prizes have been awarded under this Trust. Prizes were offered to the students of the Artistic Crafts Department of the Northampton Institute, Clerkenwell, in 1903, and have been continued annually to the present time. These have been awarded, for the present year, as follows:—

Senior Section—First Prize of £3 and a Certificate to Ernest Creedy for a Bound Book.

Junior Section—Prize of £1 10*s*. and a Certificate to Oscar John Mekelburg for a Pendant.

Prize of £1 10*s*. and a Certificate to Thomas Chilcott for a Bound Book.

A Certificate only to William Alfred Tresadern for a Bound Book.

The awards have been made on the recommendation of Mr. Alan S. Cole, C.B.

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EXAMINATIONS.

The results of the Advanced Examinations (Stage III.) were published on the 15th inst. The results of the Intermediate Examinations (Stage II.) will be published about the middle of July, and those of the Elementary (Stage I.) in August.

THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

VIII.—The Society and the Fine Arts. (1755–1851.)

(Concluded.)

Besides the prizes given to artists as encouragement for technical skill or in appreciation of genius, there were also a certain number for inventions and improvements connected with the Arts. A good many of these are trivial, but there are others of interest and some of importance in the history of the technics of Art.

A few prizes were at various times offered and awarded for artists' instruments and materials. In 1764 a premium of thirty guineas was given to Thomas Keyse for a method of fixing crayon drawings. Keyse was a still-life painter of some repute. He was also the keeper of Bermondsey Spa, where he had a gallery of his own works. The masterpiece was the interior of a butcher's shop, and over it certain of the wits of the time made merry.

In 1772 twenty guineas were given to Joseph Pache for preparing crayons, and "establishing a manufactory thereof in England." In 1781 the greater silver Palette was awarded to Thomas and William Reeves for improved water-colours. In 1794 the Palette and twenty guineas were awarded to George Blackman for his method of making oil-colour cakes. These were reported on favourably by Cosway and by Stothard, and the method of their preparation is described in the *Transactions*.† In 1803 a silver medal and ten guineas were given to James Harris for a syringe for preserving oil-colours. The syringe was of the ordinary sort, when it was filled with colour the piston was inserted and secured by screwing on the head. It was certainly an improvement on the then existing method of supplying artists' oil-colours in bladders, and received the approval of Sir Thomas Lawrence, P.R.A.

An award to William Brockedon in 1823 for a rest for painters engaged in minute work, may be noticed on account of the inventor's personality, rather than because of its intrinsic importance. Brockedon was a versatile genius, an excellent painter, a man of science (he was an F.R.S.), and an ingenious inventor. He was Chairman of the Committee of Polite Arts 1824–1831.

Besides these there were rewards for various drawing instruments and appliances, sculptors' instruments, etching fluids, drawing tablets, pencils, paper for copper-plate printing, etc.

Reference to some of these has been made in a previous article (*Journal*, January 26th), which also records the award to Senefelder for the invention of lithography.

One of the most popular things the Society ever did was its offer of a medal for a shilling colour-box, and mention may be made of it here, though we are anticipating by some half a century at least the proper course of the Society's history. This offer was made in 1851, and in the following year the medal was awarded to J. Rogers, of 133, Bunhill Row, E.C. The box has long since been obsolete, or rather has been superseded by better appliances of the same sort; but it was a very great advance on anything which existed at the time, and its enormous popularity was sufficient evidence of its value.

The proposal was put forward by Henry Cole, and was carried out with the promptitude that characterised all that remarkable man's ideas. The offer was advertised in September, 1851. The competing boxes were received on December 1st, and the award was published on January 14th, 1852. The medal was presented at the distribution of awards held by Prince Albert in 1853. According to a statement made by Sir Henry Cole,* the maker reported to him in 1870 that eleven millions of these boxes had then been sold.

At the same time a medal was offered for a cheap set of drawing instruments, to contain a pair of compasses, a drawing square, and a graduated ruler. This was awarded to J. and H. Cronmire, of Cottage Lane, Commercial Road, for two sets of instruments, one to be sold at 2*s.* 6*d.*, and one of a superior character at 6*s.* A good many of these were sold, but the drawing instruments never attained the popularity of the shilling colour-box.

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, and November 3rd, 1911, January 12th, 19th and 26th, April 5th, and June 14th, 1912.

† *Transactions*, Vol. XII. p. 271.

* "Fifty Years of Public Work," Vol. I. p. 385.

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Two prizes awarded in 1822 and 1823 mark an important though temporary modification in the technique of the engraver, the substitution of steel for copper plates. Although steel had been employed for etched plates by Albert Dürer in 1510, it had never really come into use, and until the middle of the nineteenth century copper was in practice always used by engravers. It had the advantage of being easily worked upon, and the disadvantage of only giving a small number of impressions. The precise date of the invention of the modern steel-plate seems uncertain, and the name of the inventor (if any single person can claim the credit) is also doubtful. S. T. Davenport * attributes the invention to Jacob Perkins, whose "siderographic" process for printing banknotes was mentioned in a previous article.† In the volume of the *Transactions* for 1820, in which the process is fully described, Perkins states that his method had been "in successful operation many years in America," and it certainly involved the use of engraved steel plates, but he makes no claim to having been the first to engrave on steel. He merely refers to such plates as if they were in ordinary use.‡ In the specification of his patent, taken out in October, 1819, Perkins describes a method of "decarbonating" and "reconverting" steel plates for engraving, and refers to the use of steel plates as a thing commonly known.

Early in the century Abraham Raimbach, the engraver, made some unsuccessful experiments with steel, but it seems to have been considered that the difficulties of engraving on the metal, even in a soft state, and of afterwards hardening it, were practically insuperable.

Raimbach, in his "Memoirs,"§ does not refer to his experiments, and he only alludes to steel-plate engraving as a cause of the deterioration of the art from the numbers of plates produced to comply with the popular demand, and the consequent inferiority of the work.

In 1822 T. G. Lupton was awarded a gold medal for introducing the use of soft steel for mezzotint. In a communication on the subject,‖ he says that the method of working is precisely the same as for copper plates, except that greater strength has to be used in laying the ground, and the plate has to be gone over with the tool a greater number of times.

The medal was evidently given to Lupton under the idea that he was the first to employ steel, at all events for mezzotint, and in his paper he appears to claim this credit for himself. As a matter of fact, however, he seems to have been anticipated by William Say, since there is in the collection of the British Museum a mezzotint by the latter engraver, which is dated 1817, and this is said to have been printed from a steel plate. It is from a portrait by G. Dawe, R.A., of the Princess Charlotte, the daughter of George IV., who died in 1817. This has always been believed to be the first mezzotint on steel, and inasmuch as Lupton's plate, submitted to the Society in 1822, appears from his paper to have been his first success, there is no reason to question Say's claim to priority.

In 1823 a gold medal was given to Charles Warren for "Improvements in the art of engraving on steel." These improvements consisted in substituting a plate of soft steel for the ordinary copper-plate. His process is described in the *Transactions*,* and it appears that he was led to experiment in the use of steel from early training in engraving for calico printers, and from observation of methods used in ornamenting articles of cast-steel. He began by decarbonising steel plates, and, after engraving on the softened steel (or iron), re-hardening it, but he found that plates of sufficient thinness for the purpose were apt to warp in the hardening, while there were other difficulties in using thicker plates. He was then led to try printing from the plates in their soft state, and found no difficulty in producing large numbers of impressions. The details of the method of softening the plates were improved, and it was found that editions of 4,000 and 5,000 prints could be produced without the plates showing signs of deterioration. Warren died suddenly, after the award of the medal, and before its presentation, so the account of his process in the *Transactions* is contained in a report by the committee, not in a communication from himself. So far as can be judged, the method is principally intended for etching, though available also for line engraving.

Probably the truth about the invention of steel-plate engraving is that many engravers tried to employ steel. Perkins was successful with the small plates that served his purpose, and probably those who tried to use larger plates found difficulties in the processes of

* "Engraving and other Reproductive Art Processes," *Journal*, Vol. XIII. p. 134.

† *Journal*, Jan. 26th, p. 270.

‡ E. Turrell, in a communication (*Transactions*, Vol. XLII. p. 43), says that Perkins first used steel plates "in his banknote manufactory in the United States."

§ "Memoirs of Abraham Raimbach," 1843.

‖ *Transactions*, Vol. XL. p. 41.

* *Transactions*, Vol. XLI. p. 88.

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softening and hardening the steel. Very likely, therefore, it was not till Say (possibly) and Lupton and Warren (certainly) found that steel plates could be employed without the necessity for hardening them, that such plates came into extensive use. That they did come into such use, and very rapidly, is, of course, well known. The facilities they afforded for printing large editions enabled publishers to produce the flood of "Annuals" which were popular in the thirties and forties of the last century, and served to popularise Art, if they did little to elevate it.

The copper-plate came to its own again when it was found possible to deposit upon its surface a thin film of steel, or rather iron, and thus to give it a hard "face" which would stand the wear of printing. The process was termed "acierage," and was, as all the evidence goes to show, the invention, about 1858 or a little earlier, of Henry Garnier, a Paris engraver, with whom F. Joubert, also an engraver, coöperated. Joubert brought the process over to London, and ten years later, in November, 1858, he read a very full description of it before a meeting of the Society.* The process was patented in England, March 29th, 1858, by E. A. Jacquin, as a "communication" from Henry Garnier. The process, which was merely a method of electro-deposition, came rapidly into use, and for a time was associated with Joubert's name. It proved to be of the utmost value, and has ever since been extensively applied to copper-plates of every description, including those produced by photographic methods.†

When steel was first used for etching, a difficulty was found in discovering a suitable etching fluid. Nitric acid acted too violently, and Warren recommended a solution of copper nitrate, acidified with nitric acid. In the following year (1824) Edmund Turrell‡ received a gold medal for his etching fluid, composed of pyroligneous acid, nitric acid and alcohol, and this fluid, with some modifications and the omission of the spirit, seems to have been largely used for some years for etching steel.

A few other awards in connection with plate-printing may be mentioned. In 1773, Richard Samuel received fifteen guineas for a tool for laying mezzotint grounds. Samuel was a portrait painter of no great merit, according to Redgrave. In 1776 Robert Lawrie (or Laurie), an engraver, who took several of the Society's prizes, received a "Bounty" of thirty guineas for an invention which facilitated the printing of mezzotint plates in colours.

* *Journal*, Vol. VI. p. 15.

† S. T. Davenport, in his paper above mentioned, quotes a letter from Joubert, in which it is stated that the process was patented in 1848 by M. Jacquin; but this is merely an unfortunate misprint.

‡ See his paper in Vol. XLII. of the *Transactions* above referred to.

In 1810 a silver medal and thirty guineas were given to John Hassell for improvements in the aquatint process.* His invention consisted in drawing direct on the plate with a specially prepared ink, which, when removed from the varnished plate, left the lines clear for etching. Such devices were at a later date known to and employed by aquatint workers, but the method may have been new at the date of the award.

The idea of producing prints from wood blocks in various colours is very old, and the method of colour printing for which William Savage obtained a silver medal and fifteen guineas in 1825 really involved no novel principle. He used different blocks for the different colours, and employed various devices for ensuring accurate register. Savage produced some excellent work, and devoted much attention to the subject, on which he wrote a book.†

The work done by the Society in encouraging the art of die-sinking during the latter part of the eighteenth century deserves special note. In the 1758 prize list is an announcement that "The Medallic Art being capable of great Improvement in this Nation," a prize of twenty guineas will be given for a copper medal, "after a model first produced by the candidate, and approved by the Society," the competition being limited to persons under the age of twenty-five. The offer was continued for several years, the terms being slightly varied. The age limit was raised to forty, and a second prize was offered for younger candidates.

The effort to improve the character of British medals was successful, for the result was that a number of admirable medals were produced. In some cases the candidates were allowed to choose their own subjects, in others the subjects were specified by the Society. Most of the selected subjects were British victories, of which there were, fortunately, about that time a sufficient number to provide ample choice. Several of the prizes were taken by members of the Pingo family, and, according to a statement by Dossie,‡ the designs from which the dies were cut were prepared by their father, Thomas Pingo, the engraver to the Mint.

* *Transactions*, Vol. XXVIII. p. 97.

† "Practical Thoughts on Decorative Printing," 1822.

‡ "Memoirs of Agriculture," Vol. III. p. 428.

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Thomas Pingo himself did not enter for any of the competitions, but he was paid eighty guineas for cutting the dies for the Society's first medal. His two sons, John and Lewis, carried off a number of the awards for medals, and his other children, Benjamin, Henry and Mary, took numerous prizes in other classes. Thomas Pingo was an Italian who came to England, and was appointed Engraver to the Mint, an office afterwards filled in succession by his sons, John and Lewis. In October, 1758, John Pingo produced a model for a medal with a head of Britannia, and the inscription, "O fair Britannia, hail!" On the reverse was the figure of Victory standing on the prow of a ship, with the inscription, "Louisburg taken, MDCCLVIII." This referred to the taking of Louisburg and Cape Breton by the English, under Amherst and Boscawen, in July, 1758. The model was accepted, but before the year was out, the small island of Goree, on the western coast of Africa, was captured from the French by Admiral Keppel, and the glory of this achievement was supposed to eclipse that of the taking of Louisburg. Pingo was therefore directed to make a new die for the reverse of his medal, and to cause the words "Goree taken" to replace "Louisburg taken."

In connection with the conquest of Canada four other medals were produced besides the one transferred from Canada to Africa—the first by John Pingo (1759) with the inscription "Quebec taken"; a second by Lewis Pingo (1761), "Canada subdued"; a third by Lewis Pingo (1760), commemorating the capture of Louisburg in 1758, and a fourth by John Kirk (1763), "Conquest of Canada completed." In 1762 a prize was given to John Kirk for a medal in commemoration of the brilliant exploit of Admiral Hawke off Belleisle, on November 20th, 1759. Kirk had been a pupil of J. A. Dassier, who had been engraver to the Mint about 1750. He died young in 1776. In 1763 John Pingo received a prize for a medal, the subject of which was the Battle of Minden, fought in August, 1759, and in 1765 one for a medal commemorating the Battle of Plassy, June 23rd, 1759.

Lewis Pingo also received, in 1764, 1771, and 1772, three other premiums for medals commemorating victories, the capture of Guadaloupe in 1759; the naval victory at Lagos in 1759; the capture of Havana in 1762.*

Besides these, John Pingo received an award in 1762 for an allegorical group of the Arts—"Painting, Sculpture, and Architecture"; and Lewis Pingo two awards, one in 1759 for a medal representing the granting of Magna Charta, and a second for a portrait medal of King George III. John Kirk also received a premium in 1762 for engraving a seal for the Society from a design by Cipriani, modelled by Spang, and Spang was rewarded for his model. This seal was used for many years, and when the Society was incorporated it was adopted as the Corporate seal until it was abandoned for the vastly inferior design now employed. It also

served at one time for the heading of a book-plate for the books purchased under the bequest left in 1797 by W. B. Earle.

There were also a few other awards for medals about this time. One to G. M. Moser (the first Keeper of the Royal Academy) for a medal for the Society, which does not seem to have ever been adopted; two to his nephew, Joseph Moser, in 1762 and 1763; and two to John Taylor, afterwards a jeweller at Bath, for allegorical designs.

After the date when these prizes were awarded, the subject of die-engraving dropped out of the Society's lists. Indeed, the last offer of a prize for medals appears in the list for 1765; though prizes for wax models for medallions were continued to 1770. It was one of these that Lewis Pingo obtained in 1772, and it was many years before attention was again given to the art of the medallist. Indeed, it is not until 1807 that an offer of a premium for medal die-engraving again appears, and then it does not seem to have attracted much attention. In 1817 George Mills, a medallist of repute at the time, received a gold medal for a medal die, and he followed up this success by obtaining similar awards in 1818 and in 1828, the last prize being for a new die for the Society's Vulcan medal. From 1813 to 1820 a number of gold medals were taken by members of the Wyon family, several of them for medals for the Society. Details of all of these will be found in the list

* The four medals for Belleisle, Minden, Guadaloupe, and Plassy, are in the possession of the Society.

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published in the last number of the *Journal*.* The name of Pinches appears in the list for the years 1836 and 1837, when silver medals were awarded to T. R. Pinches for medal dies, and Scipio Clint, the son of George Clint, A.R.A., the engraver, received gold medals for dies in 1824 and 1825.

It seems not unreasonable to assume that the revival of gem-engraving, which occurred in the latter part of the eighteenth century, was due, to a large extent, and perhaps entirely, to the Society of Arts. In 1759 a prize of ten guineas was offered for an intaglio on red cornelian, and it is stated that the prize was offered because, although "the Art of Engraving in Gems is a ~~very~~ ~~ancient,~~ ~~useful~~ and curious Art, and has always been esteemed, yet [it] is but little practised in this nation." The age of the candidates was limited to twenty-six. The prize was taken in 1760 by Thomas Smith, jun., for an engraving of the Meleager. In the following year the age of the candidates was reduced to twenty-four, and the prize was taken (1761) by Nathaniel Marchant, then a young man of twenty-one.

In the list of prizes issued in 1761 the age was again raised to twenty-six. This prize was taken by Edward Burch. Both Marchant and Burch became Royal Academicians, and were undoubtedly the finest gem-engravers of their day. Mr. Cecil Thomas, a most competent authority, expresses a preference for the work of the younger artist. "Marchant was easily the foremost, many of his figure-subjects being admirable and delicate examples of intaglio engraving." †

The offer of prizes was continued down to about 1770, the conditions being varied from time to time, and separate prizes being added for cameo-cutting. In the 1762 list there is no age limit. During the ten years or so for which prizes were offered Marchant took six, Burch three, Nehemiah Spicer four, Robert Staples four, John Fruin two, and Lewis Pingo one.

Cordial testimony to the value of the help given by the Society to the encouragement of gem-engraving is borne by Burch himself, who says in his catalogue of engraved gems :—

"The first step of lifting the arts from obscurity may justly be ascribed to that truly laudable and patriotic Society for the Promotion and Encouragement of Arts, Manufactures and Commerce; the Duke of Richmond's Gallery; with a valuable collection of gesses from the most admired figures and busts of the antique; and the Artists' Subscription Academy for studying after Nature. If we take these collectively, we shall there find an ample field for encouragement and improvement. First, the above honorable society who gave (with a liberal hand) premiums for history paintings, large and small models for sculpture likewise, and engravings on gems; and it is with thankfulness that I acknowledge the share I had in these honours and emoluments. Premiums were also given for engravings on copper-plate, drawings in various branches; in short, what was most for the fame and opulence of their native country was generously undertaken by them, and carried on with a spirit which must do honour to any institution."*

In the same year (1759) in which the prize for gem-engraving was first offered, a prize was also proposed for "casts or impressions in glass, commonly called pastes," "nearest in excellence to antique pastes, as well cameos as intaglios." The offer was continued in successive lists up to 1764, and after this occasionally prizes were offered for cameos and intaglios. It did not produce very much result. Two awards of twenty guineas each were made to Samuel More, afterwards Secretary to the Society and then a member, in 1763 and 1764 for two collections of such impressions, and in 1765 premiums of ten and five guineas were given to Edward Carter, a jeweller, and to Robert Fruin, a gem-engraver. No information about these imitation cameos seems to be available. Of more interest and importance is the award of ten guineas in 1767 to James Tassie for "Figures, head and portraits of his composition resembling antique onyx." Tassie soon acquired a considerable reputation, both for his copies of ancient gems and for portrait cameos modelled by himself. The paste was, according to an analysis by Professor Crum-Brown, "a very easily fusible glass, essentially a lead potash glass," and as it was reduced by a very moderate heat to a pasty consistency, it was admirably suited for taking casts from moulds of plaster or other material.† Tassie was not only a competent chemist, but a skilful modeller, and he eventually established a considerable business, which, after his death in 1799, was carried on by his nephew William. His portrait medallions and reproductions were highly appreciated, and Mr. Gray, in his memoir, quotes a letter from Shelley to Thomas Love Peacock, in 1822, asking Peacock "to get me two pounds' worth of Tassie's gems, in Leicester Square, the prettiest, according to your taste." At the

* *Journal*, June 14th, 1912.

† "Gem Engraving," *Journal*, Vol. LX. p. 366.

* From the introduction to "A Catalogue of One Hundred Proofs from Gems Engraved in England," by E. Burch, R.A., Engraver to His Majesty, for Medals and Gems; and to His Royal Highness the Duke of York. London: 1795. (Printed for the author.)

† "James and William Tassie," by John M. Gray. 1894. Mr. Gray died in the year in which his book was published.

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present time his works are of value. There is a collection of them in the possession of the Edinburgh Board of Manufacturers. Miss Catherine Andras, who received a silver palette in 1801 for her portrait-models in wax of the Princess Charlotte and Lord Nelson, is thought by Mr. Gray to have been connected with the Tassies, as some of her models were cast in their paste by them.

For a long period the subject of gem-engraving was quite neglected by the Society, so far as the offer of prizes was concerned. The subject reappears in the premium list for 1823, and from that date on prizes were occasionally given. In 1828 a gold medal was presented to C. Durham for an intaglio, and a silver medal to J. S. Phillips for a cameo. F. F. Cuisset took silver medals for intaglio in 1830 and 1832. Nothing more has been discovered about these artists' work, and their names do not appear in Forrer's Dictionary.

A gold medal was awarded in 1827 to William Warner for an intaglio of a group (Mare and Foal) which has been preserved, and is a nice piece of work. He was a seal engraver established in London, who afterwards cut some seals for Queen Victoria and the Prince Consort, as well as some medallion portraits of Napoleon III. and the Duke of Wellington. The last award which requires mention is a gold medal in 1845 to T. Moring, for an engraving on white cornelian. This is still in existence, and the writer has an impression of it.

A very important service rendered by the Society to the promotion of the Fine Arts in England, was the establishment of periodical exhibitions of the works of contemporary artists, since it was directly as a consequence of those exhibitions that the Royal Academy was founded. The Society, therefore, may legitimately claim to have been not only the precursor of the Academy, but the original source from which that great institution was developed.

That English artists should never before have adopted this method of making their works known to the public is the more extraordinary, because it had long been well known and popular in Paris. Exhibitions of contemporary pictures had been held regularly in France a century before the idea was started in this country. As a French writer on the subject says: "C'est à la France que revient l'honneur d'avoir institué les expositions périodiques des artists vivants." On the advice of Colbert, Louis XIV. suggested to his Academy of Painting and Sculpture that its members should hold an annual exhibition of their works. The proposal was accepted in 1663, though it was not till 1667 that the first Salon des Beaux Arts was opened. By the advice of Colbert the exhibition was made biennial instead of annual, and from that time it has been continued, with certain short intervals and occasional irregularities, at first biennially and afterwards annually, down to the present day. There is no need to follow the history of these exhibitions. Those who wish to do so will find an excellent account, succinct, but with full detail, in Larousse's well-known Dictionary,* from which source the above particulars are taken. Mention may, however, be made of Diderot's studies on the Salons from 1759 to 1781, collected and published in 1796, and afterwards included in a more complete form in the edition of Diderot's works, edited by Mons. Assèzat.† It does not look as if many English artists contributed to any of these Salons. The only English name mentioned by Diderot is that of Strange, the engraver.

There seems reason to believe that the idea of holding an exhibition of pictures in London was suggested by the popularity obtained by the collection of pictures at the Foundling Hospital. This collection was formed by the liberality of various artists, who contributed pictures for the decoration of the walls of the new building of the hospital, Hogarth being a principal donor, and the most eminent among the contributors. According to the statement in Austin Dobson's "Life of Hogarth," which is corroborated by information in Brownlow's account of the Foundling, the collection was formed about 1746. It soon became a popular resort, and the artists who had given the pictures found a good deal of benefit from the advertisement, though there was no actual profit, as nothing was charged for admission.

The very moderate publicity thus given to the pictures of a few artists seems to have suggested the idea that an exhibition on a larger scale would be highly profitable, by attracting the attention of the public and giving artists generally an opportunity of making their works known. At any rate, it is certain that, whether in consequence of the Foundling collection or not, a committee of artists was formed, in 1759 or 1760, at the "St. Martin's Lane Academy"—the well-known painting school previously referred to in these notes—with the object of promoting the formation of a regular exhibition

* "Grand Dictionnaire Universel du XIX[e] Siècle," Art. Salon, Vol. XIV. p. 136 (1875).

† "Œuvres complètes de Diderot." Par J. Assèzat, 1876.

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of paintings. Of this committee, Mr. Francis Hayman, an active member of the Society of Arts, and afterwards an original Royal Academician, was chairman.

The Society had moved into its new premises opposite Beaufort Buildings in 1759,* and one of the reasons for its move was the acquisition of a "Great Room," in which could be exhibited the pictures and other works of Art to which its premiums had been awarded. It had, therefore, facilities for holding an exhibition on a large scale (the Great Room was 80 ft. by 40 ft.), and had already held exhibitions of a less important character. Hayman, therefore, very naturally appealed to the Society for its aid.

This he did by making a formal application, since it appears from the minutes of the Society of Arts that on February 27th, 1760, "A letter from Mr. Francis Hayman, Chairman of the Committee of Artists, was read, desiring the use of the Society's room for exhibiting paintings, etc." The letter was referred to a large and important committee, including among its members, Israel Wilkes, R. E. Pine, Sir George Savile, Lord Ward, P. Carteret Webb, Mr. Chambers, Lord Middleton, Sir Thomas Robinson, Thomas Hollis, Dr. Knight, and Henry Baker. The committee reported on March 5th that "they are of opinion that the Society may allow a Public Exhibition of Productions in the Polite Arts for one fortnight this year under such regulations and restrictions as the Society shall hereafter prescribe."†

Regulations were accordingly prepared, under which all pictures sent in by the committee of artists were to be accepted, all other pictures being selected by a committee of the Society. The Society's committee was to be the hanging committee, and to "appoint the places where all the productions may be hung or exhibited, in case any dispute shall arise among the artists about placing them." No charge was to be made for admission.

It is quite clear that, although the Society accepted the proposition of the artists for an exhibition, they took care to reserve to themselves all the arrangements—so that it was, in fact, the Society's exhibition. All the costs and charges were borne by the Society, and it appears from the account books that though they paid all the expenses, they received nothing whatever in return. More than this, the Society's committee were responsible for all the details of the arrangements, the printing of the tickets, the preparation of the catalogue, etc. Pictures sent in by the committee of artists were accepted, but that was all they had to do with the management of the exhibition.

In the exhibition there were 130 pictures by sixty-nine painters. The best artists were well represented. Reynolds had four portraits, Richard Wilson three landscapes, Hayman his well-known picture of Garrick as Richard III., and Cosway the portrait of Shipley. Among other important exhibitors may be mentioned Highmore, Morland, Pine, Sandby, Carlini, Moser, Pingo, Roubiliac, Wilton, MacArdell, Gwynn, Rooker, Strange, and Woollett. The title of the catalogue, which was sold for sixpence, was "A Catalogue of the Pictures, Sculptures, Models, Drawings, Prints, &c., of the present Artists, exhibited at the Great Room of the Society for the Encouragement of Arts, Manufactures, and Commerce, on the 21 of April, 1760."

The exhibition was a success, but, unfortunately, a success which led to disaster, for a disagreement arose among the exhibitors as to the use to be made of the money received at the door in exchange for catalogues. This amounted to one hundred pounds, and the money was, apparently, left to the disposal of the contributors. The Society certainly never had or asked for any of it. It appears to have been invested, and was probably added to the fund devoted, as is mentioned later, to charitable purposes. In consequence of the dispute there were two rival exhibitions in 1761. The chief artists seceded, and formed themselves into the Society of Artists of Great Britain, which exhibited in Spring Gardens, and the Society of Arts continued its patronage to the others, who subsequently styled themselves the Free Society of Artists. Each body took credit for the exhibition of 1760, and counted its own exhibition of 1761 as the second.

The Society's exhibitions were continued for four more years—1761 to 1764—and they were principally supported by those artists who eventually became the Free Society of Artists. These exhibitions all seem to have been well supported. But the artists who contributed, although distinguished, were neither so numerous nor so important as those who had seceded, and who contributed to the rival exhibition of the Society of Artists of Great Britain.

It was definitely decided, and notices were

* See *Journal*, September 22nd, 1911.

† This account of the Society's early exhibitions of pictures has been somewhat condensed from the article by Mr. H. B. Wheatley in the *Journal*, September 6th, 1895. The rather fuller details contained in that article are very interesting, and it will well repay perusal.

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printed on the catalogues, that the money arising from the sale of the catalogues, which formed the only profits of the exhibition, was to be given "by the artists immediately after the exhibition to some public charity." There seems to have been a certain amount of trouble in consequence of the numbers who came in, as no admission fee was charged, and it was found necessary to employ a number of constables to control the crowd.

After 1764 the Society decided to discontinue the exhibitions, but the artists held exhibitions in 1765 and 1766, in "Mr. Moreing's Great Room in Maiden Lane, Covent Garden." In 1767 the Free Society of Artists was definitely formed, and they held annual exhibitions up to 1783—first in "the two new Great Exhibition Rooms in the Pall Mall, near the bottom of Hay Market," then in "Mr. Christie's new Great Room, next Cumberland House, Pall Mall,"* and after this, in rooms in or near the Haymarket.

The "Society of Artists of Great Britain," on leaving the Society of Arts, went to "the Great Room in Spring Garden, Charing Cross." It is not quite certain where this room was situated, but it is supposed to be now incorporated in the offices of the London County Council. As previously stated, the chief cause of the split among the artists was a dispute as to the use to be made of the money obtained from the sale of the catalogues; but it is evident that the ruling of the Society of Arts, that no charge should be made for admission, had much to do with the decision of the chief artists to go elsewhere, for in the preface of the catalogue of the Society of Artists for 1762, which was written by Dr. Johnson, we read:—

"Of the price put upon this exhibition some account may be demanded. Whosoever sets his work to be shewn naturally desires a multitude of spectators, but his desire defeats its own end when spectators assemble in such numbers as to obstruct one another. Though we are far from wishing to diminish the pleasures or depreciate the sentiments of any class of the community, we know, however, what every one knows, that all cannot be judges or purchasers of works of art, yet we have already found by experience that all are desirous to see an exhibition. When the terms of admission were low, our room was throng'd with such multitudes as made access dangerous, and frightened away those whose approbation was most desired."

These remarks form a curious commentary on the precautions found necessary by the Society of Arts, which have been previously alluded to. They also show how highly popular these newly established exhibitions became.

The exhibition of the Society of Artists of Great Britain for 1761 is styled on the catalogue "the second year," but no explanation of the secession from the exhibition of the Society of Arts is made. This catalogue contains a frontispiece by Hogarth, representing Britannia as watering the roots of three trees, labelled respectively painting, sculpture, and architecture, from a fountain surmounted by a bust of George III. Hogarth himself exhibited no less than seven pictures, among which were his celebrated "Sigismunda," the "Gate of Calais," "Picquet, or Virtue in Danger," and "The Election." Gainsborough sent a portrait, Reynolds five portraits, Richard Wilson six landscapes, and Francis Hayman a picture of "Sir John Falstaff." The receipts from this exhibition were £650.

The Society of Artists of Great Britain obtained a Charter and a coat of arms in 1765, and became known as the Incorporated Society of Artists. George Lambert was appointed the first president, Francis Hayman the first vice-president, and F. M. Newton the first secretary. The Incorporated Society seemed to be on the high road to prosperity, but, in spite of complaints, it did nothing for teaching, and formed no school, so that many of the leading artists became disgusted, and again there was a secession. The seceders applied for a charter for an academy, which was granted, and the Royal Academy was founded in 1768. From that date the Incorporated Society steadily declined, although, for a time, some of the Royal Academicians continued to send to its exhibitions.

The exhibitions of the Incorporated Society continued to be held in Spring Gardens until 1771. In the following year the Society removed to their "new room near Exeter Exchange," which was on the site of what is now the Lyceum Theatre. In 1777 the Society went to Piccadilly, near Air Street; in 1780 to Spring Gardens, and in 1783 to Exeter Exchange again. No exhibition was held between 1783 and 1790, when a final exhibition was held, and after this the Incorporated Society came to an end.

For at least fourteen years previously various proposals had been made in different quarters for the formation of an Academy of Arts. Soon after the Society of Arts had been established, a suggestion was considered that the Society itself should apply for a charter for an Academy of Painting, Sculpture, etc. The principal advocate

* Cumberland House was afterwards part of the War Office, and was pulled down when the Automobile Club was built in 1910.

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of the scheme was Henry Cheere (afterwards Sir Henry Cheere), and he was warmly supported by Dr. Madden. The full text of his proposal, with the draft of a charter for a Royal Academy, is preserved in Dr. Templeman's MS. volume of *Transactions* previously referred to. The proposal, however, was not approved, and the Society even refused to offer one of its prizes for a scheme for such an Academy.

Even before the establishment of the Society a definite proposal for an Academy of Fine Arts had been put forward. In 1753, a number of artists, under the chairmanship of Francis Hayman, actually held a meeting to discuss the project. The official notification of the meeting, held on November 13th, is as follows :—

"There is a scheme on foot for creating a public Academy for the improvement of painting, sculpture, and architecture, and it is thought necessary to have a certain number of professors with proper authority in order to making regulations, taking subscriptions, etc., erecting a building, instructing the students, and concerting all such measures as shall be afterwards thought necessary. Your company is desired at the Turk's Head, in Gerard Street, Soho, on the 13th November, at five in the evening, to proceed to the election of thirteen painters, three sculptors, one chaser, two engravers, and two architects, in all twenty-four, for the purpose aforesaid (*signed*), Francis Milner Newton, *Secretary*." *

No agreement was come to at the meeting, and the projectors were satirised by their fellow artists, and became the objects of several caricatures.

The reason why these proposals all failed, and why the Royal Academy succeeded, was, as has been pointed out by Messrs. Hodgson and Eaton in their "History of the Royal Academy," that its projectors had realised that there was a source of revenue in the holding of exhibitions of pictures. The hundred pounds taken at the Society's first exhibition proved that, and further confirmation was provided by the larger receipts at those exhibitions when a charge was made for admission. The founders of the Royal Academy made good use of their experience, and from their day to our own the Academy has earned much money by its exhibitions, and has applied that money wisely and well to the education of artists.

It is interesting to note that while the constitution of the Academy, as defined in the "Instrument" or charter, granted by George III., is entirely different from that proposed in the scheme for an Academy of Painting submitted to the Society in 1755 by Sir Henry Cheere, its objects, and the methods of attaining them, are identical with those set forth in the original proposal. Those who drafted the older scheme evidently had in their minds the establishment of an institution similar to the Royal Society. Their Academy was to consist of an unlimited number of Fellows with a president and a council, whereas the founders of the Royal Academy took for their model the French Academy of Louis XIV. with its forty members, the governing body being a council of eight, on which all Academicians served in rotation. When, however, they came to details, they practically adopted the scheme set out in Cheere's draft charter, which proposed an annual exhibition, the appointment of professors (anatomy, geometry, perspective, architecture, antiquity, and "other studies"), and a drawing-master, the establishment of a school with models, the provision of medals, etc. Practically the same establishment is provided in the "Instrument," which, though obsolete in some particulars and modified in others, is still the fundamental charter of the Academy.

Had the original proposal been carried out, there can be little doubt that the Society would have been merged in the Academy, which would almost certainly have developed on its present lines. It is, therefore, probable that much of the useful work carried out by the Society in the first half century of its existence would never have been accomplished, and it is highly unlikely that any improvement would have been effected in the methods of the Academy. Probably the net result would have been that Art would not have benefited, while agriculture, invention, industry and commerce would, for a time at least, have suffered. So while the Society of Arts may take a legitimate pride in the share it had in preparing the way for the establishment of the Royal Academy, it may also congratulate itself on the fact that the attempt to concentrate in the hands of a single institution the work of supervising and promoting all the arts and industries of the country did not succeed.

* Rimbault's "Soho" (1895), pp. 194, 195, quoted by Mr. H. B. Wheatley.

MEXICAN FIBRE-PRODUCING PLANTS.

A great variety of fibre-producing plants, which could be utilised in the manufacture of cordage and kindred industries, are to be found growing wild in the State of Tabasco, Mexico, but their proper classification, and the numerous uses to which they can be applied, have been ignored,

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In the municipalities of Cardenas, Comalcalco, Paraiso, and Nacajuca, extensive tracts of land are covered with an exuberant growth of the pita plant. Possibly, with the exception of ramie, the pita produces the finest fibre of all textile plants. It is said that, although its weight is one-fourth that of hemp, its tensile strength is fully three to four times greater, and its qualities are not impaired by exposure to the severest weather or immersion in water. Its fibre is glossy white with a silken sheen, and it could no doubt be utilised in the manufacture of linen cloth. Paper manufactured from this fibre has a beautiful white, smooth surface, and is of greater strength and lasting qualities than linen paper. The pita leaves are eight to twelve feet long and about two to three inches broad, gradually tapering to a switch-like point. It is stated that about ninety leaves will produce two pounds of fibre, and that the leaves from each plant can be removed at least three times during the year, each plant producing two to three pounds of fibre annually. In rich soil the pita plant will reach full development in two years. It thrives best in low, wet lands under dense shade, where water is constantly evaporated instead of becoming stagnant. The American Consul at Frontera says that, at present, this fibre can be obtained only in small quantities, owing to primitive processes employed by the Indians in its extraction. They place the long slender leaves on a smooth board in a slanting position, and with the thin edge of a rib of a horse or cow, which they select as nearly semi-circular as possible, remove the pulp from both surfaces of the leaf. The fibre is then dried in the sun, and after a short exposure becomes beautifully white and glossy. The Indians dwelling on the border of the States of Tabasco and Chiapas manufacture hats and reticules with this fibre, which are exceedingly fine. The women occasionally manufacture handkerchiefs equal in appearance to the finest linen. During an inspection of the woodlands in the immediate vicinity of Frontera about two years ago, for the purpose of obtaining data relative to the textile plants of the State, a fibre-producing plant was found, the exact name of which could not be ascertained. A small plant was transplanted in the garden of the American Consul at Frontera, and has developed into a vigorous plant, the leaves now being four feet long and three to four inches wide. Their formation is quite similar to the sisal leaves of the Yucatan and zapupe of Tuxpam, State of Vera Cruz, having, like these leaves, a sharp, needle-like spike at their tips; but, unlike zapupe or sisal, they have no spines along either edge, which is a great advantage, as it takes a long time to remove them. Natives state that this plant is known as an agave. The fibre of this plant is superior to zapupe or sisal, and, while not as fine as the pita, it possesses, to a certain extent, many of its qualities. If properly cultivated, it would, it is said, undoubtedly produce a valuable fibre for commercial purposes, and could be produced in enormous quantities on the rich lands of the State of Tabasco. Numerous other textile plants are found in the forests of Tabasco, such as the ramie, chimbombo, various species of the agave, and jolocin, which forms the inside tissue that is attached to the wood proper and outside bark of the jolocin tree. It is employed by the Indians in making bagging and ropes, and when roughly twisted in several strands is used by them as traces for their carts or as girths for saddles.

OBITUARY.

Shadworth Hollway Hodgson, LL.D., F.B.A. —Mr. Shadworth H. Hodgson died at his rooms in Conduit Street on the 13th inst., at the age of seventy-nine. He was educated at Rugby and Corpus Christi College, Oxford, of which, at the time of his death, he was an Honorary Fellow. Being left a widower in 1858, after only three years of married life, he devoted himself, with increasing zeal, to the study of philosophy. His first work of importance was "Time and Space, a Metaphysical Essay," published in 1865; and this was followed by "Principles of Reform in the Suffrage" (1866), "The Theory of Practice" (1870), "The Philosophy of Reflection" (1878), "Outcast Essays and Verse Translations" (1881), and "The Metaphysic of Experience," his *magnum opus*, which was completed in four volumes in 1898.

Though Mr. Hodgson's writings naturally did not appeal much to the general public, they were eagerly appreciated by all serious students of philosophy. He was a man of immense learning, with a first-hand knowledge of practically every philosophical work, ancient and modern. The first president of the Aristotelian Society, he continued to frequent its meetings until a few months before his death. He received the honorary degree of LL.D. from the University of Edinburgh, and he was a corresponding member of the French Academy of Moral Science, and a Fellow of the British Academy. He joined the Royal Society of Arts in 1871.

John Godfree Single, M.Inst.C.E.—Information has been received of the death of Mr. John Godfree Single, which took place at his residence in his native town, Plymouth, on April 17th. Mr. Single was born in 1846. He went out to India in 1869, and served as executive engineer in H.M. Public Works Department, his duties being to a large extent concerned with the banks of the Indus. He took great interest in military matters, and at one time was Captain Commanding the Sukkur Detachment of the Sind Rifle Corps (Volunteers). Since his retirement, some twenty years ago, he resided in Plymouth. He became a member of the Royal Society of Arts in 1881.

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GENERAL NOTES.

COTTON IN INDIA.—The report on the progress of agriculture in India for 1910-11 contains an interesting section on the cotton crop. Owing to the steady spread of the cotton-boll weevil in America, and the general increase in the demand for cotton, the importance of India as a grower for the world's markets has been brought into great prominence. Systematic efforts are therefore being made by the Agricultural Department to improve both the quality and the quantity of the staple. In Madras the improvements have taken two lines: one, the separation and selection of the best indigenous variety, resulting in the spread of the improved local species called *Karungani;* the other, the introduction of *Cambodia,* which ranks in quality with the best American cotton, and is suitable for the Liverpool market. Its yield per acre is four to five times as great as that of the indigenous cottons; it is expected that it will soon be found in every part of the country, and that it will revolutionise the Indian cotton industry. The crop last year was 33,000 bales, valued at Rs. 60,00,000. Most of this out-turn has been taken over at full prices by mills in Madras which are weaving with it a quality of cloth never before woven by machinery in India; while one firm alone last year shipped 10,000 bales direct to Liverpool. Good progress in the improvement of cotton has also been made in the Central Provinces. There are now 100 cotton-seed farms in Berar alone, covering an area of some 4,000 acres, and capable of producing 1,000,000 lbs. of pure seed per annum for distribution to growers. These farms do not belong to Government, though the work is controlled and supervised by officers of the department. They are owned by land-holders who have been induced by the authorities to grow pure seed of improved varieties for supply to cultivators.

THE NEW SCIENCE MUSEUM.—The report just issued by the Departmental Committee on the Science Museum and the Geological Museum, shows that considerable progress has been made in connection with the plans of the new building. The site lies between the Natural History Museum in Cromwell Road and the Imperial College of Science and Technology in Imperial Institute Road, its length from east to west being 1,150 feet. It will have a frontage of some 190 feet in Exhibition Road, and another of some 170 feet in Queen's Gate. At the two ends it is proposed to build large halls with surrounding galleries, which will make full use of the space, and form suitable accommodation for exhibiting the collections effectively. The central portion "may well be occupied by lofty buildings, such as would be required to enclose a hall worthy of its place in the centre of the Museum"; and this central hall will be connected with the east and west halls by comparatively low side-lit galleries. The complete scheme of the building for the Science Museum provides 377,000 square feet of floor space. The building for the Geological Museum, which will occupy a site east of the Natural History Museum, and between it and Exhibition Road, will provide about 80,000 square feet of floor space.

EXHIBITION OF IRRIGATION AT VERCELLI.—It is announced that an exhibition of irrigation and rice culture will be held at Vercelli next autumn, from October 10th to November 10th. This exhibition will embrace all subjects connected with the cultivation of rice and its preparation for the market. The irrigation department will include the following nine subdivisions, viz.: Head works and intakes, dams, artesian wells, mechanical appliances for irrigation, methods and appliances for the measurement of water, appliances for raising water, reservoirs and storage of water, co-operative societies for irrigation, monographs on irrigation. Situated half-way between Turin and Milan—the classical land of Italian irrigation—the town of Vercelli is most favourably placed for visiting many important works of the kind, including the Cavour Canal opened in 1866, by means of which the fertilising waters from the river Po are brought to the land.

COMMERCE OF THE ISLAND OF RHODES.—No time has been lost since the occupation of Rhodes by the Italians in promoting and encouraging the trade between the island and Italy. Much information on the subject has been collected by the Civil authorities, and, for the guidance of manufacturers and merchants at home, a list of the names of the principal trades and the chief articles in demand has just been published by a leading commercial journal, *Il Sole,* of Milan. From this it appears that, whilst some of the most important island firms send their orders direct to Italy or other European countries, the majority obtain their goods through agents established at Constantinople or in other commercial cities in Turkey. A few of the principal firms in Rhodes supply the retail dealers in the other islands of the Archipelago, as well as in some of the principal towns in Anatolia. The list contains the names of about twenty retail traders in Rhodes who are supplied by the local wholesale firms as well as by other firms in Turkey. Amongst the principal goods which find a ready market at Rhodes may be mentioned:—cotton and woollen manufactured goods, rope and cordage, yarn, glass, crockery and earthenware, mirrors, furniture, caps, haberdashery, sewing cotton, enamelled ware, hardware, ironmongery, drugs, sulphur, matches, etc., preserved food in tins, coffee, sugar, butter, cheese, flour, beer, soap, candles, paint, varnish, etc. An import duty of 11 per cent. *ad valorem* is levied by the Government on all goods introduced into the island. Amongst the principal exports may be mentioned dried figs, sesame, almonds, and carobs.

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Journal of the Royal Society of Arts.

No. 3,110. VOL. LX.

FRIDAY, JUNE 28, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The one hundred and fifty-eighth Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments during the past year, and also for the Election of Officers and New Members, was held in accordance with the By-laws on Wednesday last, June 26th, at 4 p.m., LORD SANDERSON, G.C.B., K.C.M.G., Chairman of the Council, in the chair.

The SECRETARY read the notice convening the meeting, and the Minutes of the last Annual Meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Abraham, Edward A. V., America-street, Georgetown, Demerara, British Guiana.

Ahmad, Maulavi Sayyid Makbûl, M.R.A.S., Fatehgarh, United Provinces, India.

Banks, Alexander, A.M.I.Mech.E., Manganese Bronze and Brass Company, St. George's Wharf, Deptford, S.E.

Brigstocke, Arthur Montagu, I.C.S., Lahore, Punjab, India.

Carter, Leslie, Warren Cottage, near Ashington, Sussex; and 26, Steele's-road, Haverstock-hill, N.W.

Chipperfield, Walter, Roneo Works, Romford, Essex.

Clench, Edward Claude Shakespeare, The Aster Engineering Company, Wembley, Middlesex.

Evans, William Steward, P.O. Box 274, Bloemfontein, Orange River Colony, South Africa.

Exley, J. R. G., A.R.C.A., A.R.E., Lugano, Hills-road, Cambridge.

Hatton, James, A.M.I.Mech.E., 49, Jesmond Dene-road, Jesmond, Newcastle-on-Tyne.

Hill, Harold, 322, Blackburn-road, Bolton.

Howard, John, 43, Garden Reach, Calcutta, India.

Khan, Khan Bahadur Habibur Rahman, Indian Telegraph Department, Quetta, Baluchistan, India.

Kwegyir-Aggrey, Professor J. E., M.A., Livingstone College, Salisbury, North Carolina, U.S.A.

MacDonald, Miss Eleanor, The Fort, Fort Qu'Appelle, Saskatchewan, Canada.

Mills, Sidney Carton, 24, Hillside-road, Stamford-hill, N.

Osgood, Mrs. Irene, Guilsborough Hall, Northampton.

Pooley, Ernest Henry, M.A., LL.B., Drapers' Hall, Throgmorton-street, E.C.

Prashad, Rai Bahadur Ashtabhuja, Bansi Ditt, Basti, United Provinces, India.

Priestley, Neville, Roadside, 102, West-hill, East Putney, S.W.

Pulford, William Henry, 132, Clement's-road, East Ham, E.

Raymond, Professor George Lansing, 24, St. James'-park, Los Angeles, California, U.S.A.

Reindorf, Christian J., Accra, Gold Coast Colony, West Africa.

Riviere, Donald Osmund, Chambers, Roseau, Dominica, British West Indies.

Rosanoff, M. A., Sc.D., Clark University, Worcester, Massachusetts, U.S.A.

Smallbones, Robert Townsend, Loanda, Portuguese West Africa.

Smith, Henry, 24, Haymarket, S.W.

Speaker, Gustave Robert, 28, Mark-lane, E.C., and 71, Cadogan-place, S.W.

Stevens, George Nevill, Tapah, Perak, Federated Malay States.

Szymanowski, Konrad, A.M.I.Mech.E., 4, Wosnessenski-prospect, St. Petersburg, Russia.

Visram, A. Allidina, Mombasa, British East Africa.

Williams, Samuel Beckerleg, Penelvan, Roskear, Camborne, Cornwall.

The CHAIRMAN appointed Mr. Byron Brenan, C.M.G., and Mr. John Armstrong scrutineers, and declared the ballot open.

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The SECRETARY then read the following—

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS.

The subject which Lord Sanderson selected for the address with which, as Chairman of the Council, he commenced the session last November was "The Development of International Intercourse." He sketched very briefly this development, beginning with Egyptian and Babylonian records, and drew attention to the immensely accelerated progress which had taken place in the last century. Finally, he enforced the conclusions at which he arrived by a valuable table, showing the comparative growth of foreign trade during the past fifty years.

Among the papers which have been read at the Ordinary Meetings, the Society has been fortunate in securing even more than the usual number of papers dealing with recent applications of scientific investigation. The first of such papers was the one read by Mr. A. E. Berriman on Aeroplane Efficiency, in which the various questions relating to the development of the aeroplane were ably dealt with. The problems with which future constructors of aeroplanes have to deal are difficult and complicated, and it is certain that a vast amount of experimental investigation is yet necessary. Mr. Berriman's communication to the Society was a valuable contribution to the theory on which such experimental investigation will have to be based.

The next paper which may be treated as belonging to the same category was that read by Professor G. W. Osborn Howe on "Recent Progress in Radio-Telegraphy." Here, again, we had a valuable paper dealing with the theory of an extremely difficult subject, though Professor Howe treated his material in a less technical fashion than Mr. Berriman, and succeeded in explaining satisfactorily to a non-specialised audience the principles of wireless telegraphy.

In their joint paper on "The Influence of Ozone in Ventilation," Dr. Leonard Hill and Mr. Martin Flack, who have been working on the subject in conjunction, succeeded in starting many novel ideas concerning a well-worn subject on which the Society has had many papers in previous sessions. Ozone is now being experimented with on a very large scale for ventilating purposes, and there seems every reason to expect that its application will be of considerable value. It is certain that it must be used with judgment, because its use in excessive quantities has a very great irritative effect on the human lungs and the whole respiratory tract.

The problem of illumination was dealt with a few years ago in an able course of Cantor lectures by Mr. Leon Gaster. In his paper on the subject Mr. Thorne Baker discussed the most recent sources of artificial illumination, and considered not only the question of the production of a light most nearly approaching daylight, but also the effect of the different artificial lights used, both in their technical applications and in their effect on human vision.

The last paper coming under this classification was the able communication by Mr. Ernest Kilburn Scott on "The Manufacture of Nitrates from the Atmosphere," which was read at the last meeting of the session. Mr. Scott was able to put forward an independent view of the two rival methods of producing artificial nitrates —the one now being conducted on a large scale in Norway, mainly as the result of the investigations of Professor Birkeland, and the methods for the production of cyanamide, which are for the most part at the present time carried on in Italy. Besides describing the methods of manufacture, and the already extensive applications of the products for the manufacture of artificial manures, Mr. Scott drew attention to their other uses, especially for the production of explosives. He pointed out that, whereas sodium nitrate is the most important ingredient in most modern explosives, gun-cotton, dynamite, and smokeless powders, there is at present no factory for its production in Great Britain, whilst there are factories on the Continent the whole of whose products are employed for the manufacture of explosives, and are taken over entirely by the Government of the country in which the material is produced.

The papers which came under the category of Applied Art were also of a very high class. Mr. Cyril Davenport, to whom the Society has been indebted in past years for many valuable communications, read an extremely interesting paper on Illuminated Manuscripts. As on previous occasions, the paper was illustrated with a very beautiful collection of lantern-slides painted by Mr. Davenport himself.

Mr. Cecil Thomas, in his paper, dealt with a subject in which the Society has always been deeply interested—that of Gem Engraving. The first prize for gem engraving was awarded by the Society in 1760, and for many years after this the prizes awarded did a good deal to encourage the progress in England of this very beautiful art. Mr. Thomas gave a

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slight but sufficient sketch of the history of the subject, and this led up to an account of the present condition of the art, which, thanks to Mr. Thomas and a few other English artists, is now in an improving condition in this country; and it is to be hoped that the present revival of a very ancient and beautiful art will continue to progress.

The third paper dealing with matters of Art was the one read by Professor Ernest Gardner on Greek Sculpture. This admirable discourse was of purely archæological and artistic interest, and did not profess to have any application to modern industry, though the suggestions made in the paper, and the discussion as to the experimental reproduction of the most celebrated examples of chrys-elephantine statuary, may possibly produce practical results.

Mr. William Burton's paper on "Ancient Egyptian Ceramics" might not unreasonably be classed amongst those devoted to Industrial Art; but it is certainly more properly placed amongst those dealing with industry. It had an important archæological application, for, if his theory is correct, the specimens of pottery which have always been considered Egyptian are, according to his analysis, specimens of an art anterior to that of the potter, viz., that of glazing carved sandstone figures. His paper may throw light on the history of the origin itself.

Mr. Frank Warner, in his paper on the British Silk Industry, dealt with matters of a very different date, and so far from discussing questions of pre-historic art and manufacture, it was devoted entirely to the development of the industry during the past nine or ten years. It is satisfactory to be able to say that, in the opinion of so competent an authority, the silk industry of this country at the present time is, in spite of a good many difficulties, flourishing and prosperous.

Yet another industry, once a flourishing one and now revived, was dealt with by Mr. Theodore Salvesen in his paper on "The Whaling Industry of To-day." From the middle of the eighteenth to the middle of the nineteenth century the whale fishery was one of the important industries of the country, and one which the Society of Arts did not a little to assist by its encouragement of the gun-harpoon as a substitute for the hand-weapon. The whalers of Great Britain and the United States, however, followed their pursuit with such energy that the "Right Whale," which for long was esteemed the only one worth seeking, became so much diminished in numbers that it hardly paid to fit out vessels for its capture. Although whaling was continued mainly for the capture of the Cachalot, it had, at all events in this country, almost died out until it was recently resuscitated here and in Norway by an entire revolution of the methods adopted and a change in the animals sought for. The modern whaler, instead of starting for long voyages and remaining at sea until he has filled his hold with the products of his pursuit, now works from a station on land. He employs a small vessel, and tows his captured prey to the shore, where it is treated in such fashion that almost every part of the animal is rendered valuable for some product or another. He also, instead of pursuing the whale in boats with a hand-weapon, uses a gun of the same character as that rewarded years ago by the Society, but of a very different construction, and mounted on his steamer, with the result that the industry has been revived, and is now an extremely prosperous one, though how long it will be before it follows the fate of its predecessor is not very easy to foretell.

Mr. Martin Duncan's paper on the Marine Biological Association ought to be mentioned in succession to Mr. Salvesen's, because the work which the Association has done has had such an important bearing on British Fisheries, one of the greatest and most important of our industries.

Another paper may be classed as an industrial one, not because it dealt with any special industry, but because it gave an account of a process likely to be applicable to a good many industries—namely, the paper read by Mr. W. J. Gee, on his process for the Separation and Grading of Solids. If we may judge from the attention attracted to Mr. Gee's paper, and the correspondence which it involved, the process is likely to come into extensive application, and to prove of very great use.

Perhaps Mr. Yorath Lewis's paper, on what he terms "Continuous Passenger Transportation," may be classified with those dealing with industrial matters, because the question of the transportation of both passengers and goods is becoming one of pressing interest, almost it might be said of emergency, in relation to industry. Mr. Lewis described a scheme under which transportation in thickly-populated cities would be effected by means of underground or tube railways, on which trains would run continuously without actually stopping, but, while passing through the stations, slackening the speed sufficiently to allow the passengers to enter and leave the cars. The whole scheme has been thoroughly worked out by Mr. Lewis, and

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the paper contains full information of all the necessary engineering details.

During the session three papers on educational subjects were read. The first of these was by Mr. H. A. Roberts, Secretary of the Cambridge University Appointments Board, which has been of such valuable service in assisting young graduates to find suitable opportunities for earning their living. Mr. Roberts's subject was "Education in Science as a Preparation for Industrial Work," and this precisely describes the scope of his paper, which was an excellent and forcible appeal on behalf of the educated graduate to those who are at the head of great industrial concerns. Mr. Roberts showed how much had already been done in utilising the services of young men with a sound scientific training, and pointed out how much there was yet left to be accomplished in this direction.

Another branch of the same subject was treated by Mr. J. H. Coste, in his paper entitled "Municipal Chemistry," for this, to a very large extent, dealt with the necessity for the employment of competent and qualified chemists in the great variety of work which is now coming into the hands of municipal corporations.

The other paper on Education was an excellent address by Mr. George Fletcher, Assistant Secretary of the Department of Agriculture and Technical Instruction for Ireland, on "Technical Education in Ireland." Mr. Fletcher gave a very full account of all that has been done in this direction, and indicated how much might be hoped with regard to the future prosperity of Ireland, if the work could be continued and developed on the same lines and to a greater extent.

Two papers, both read in the early part of the session, may be classed together as of a historical nature—Mr. James Douglas's account of "The Industrial Progress of the United States of America," and Mr. J. A. J. de Villiers's paper on "British Guiana and its Founder." Of the two Mr. de Villiers's was of purely archæological interest, while Mr. Douglas's dealt with the recent industrial progress of the States.

Only one more paper remains to be noted, and that was the attractive and brilliant account of British rule in Nigeria, which was given by Mr. E. D. Morel. Mr. Morel's articles in the *Times*, since republished as a book, gave a great deal of information, which, if not new to experts, was certainly not familiar even to the well-informed public, about the ancient negro and Arab civilisation which existed in the country now known as Northern Nigeria, and the French districts to the north of it, and also about the effect of modern colonisation and modern civilised influence, which has lately been brought into contact with the relics of the ancient civilisation which still existed in Kano and Timbuctu.

II.—Indian Section.

The story of the North-Eastern Frontier of India was told by Sir Thomas H. Holdich at one of the earlier meetings of the Section. After vividly describing the physical features of this remote corner of our Indian Empire, he referred to the proposed land connection with China and Burma. It is, he thinks, impossible to look to a long future without the conviction that India will eventually be linked by a railway "which will render a complete command of all contiguous tribes a political necessity." Of the three possible ways of entering Burma from India, he expressed a preference for that *via* the Hukong Valley, the great commercial possibilities of which were emphasised by Sir Eric Swayne, under whose direction this route was surveyed sixteen years ago. Sir George Scott (Shway Yoe), among others, took part in the discussion on Sir Thomas Holdich's singularly interesting paper.

The first-fruits of the Indian Census of last year were given to the Section by Mr. E. A. Gait, I.C.S., C.I.E., whose valuable paper, written in India, was read in the author's absence by Mr. J. D. Anderson. When, by desire of the Society, the Census Commissioner kindly prepared the paper, barely twelve months had elapsed since the census was taken. A portion of the final tables was still incomplete, and none of the provincial reports had been sent in. Consequently it was impossible for Mr. Gait to deal, as the writers of some of the Society's previous papers on Indian censuses have done, with certain branches of the subject, such as migration, caste, and occupation. Mr. Gait, therefore, confined himself in this preliminary survey to a presentation of the main features of the statistics and to a consideration of the broad conclusions to be drawn from them. The efficiency of his plans for taking the census was shown by the remarkable speed with which the provisional totals were got in. The results for the whole of India with its teeming population were received complete at headquarters within nine days and issued in print next morning, with full details not only for Provinces and "Agencies," but also for Districts and States and the principal towns. This, as Mr. Gait pointed out, constitutes a record. The Registrar-General (Mr.

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Bernard Mallet, C.B.) took part in the discussion on the paper, and as the authority responsible for the recent census in England and Wales paid a tribute to Mr. Gait for the "splendid success of his vast undertaking." Sir Chichele Plowden, Census Commissioner in India in 1881, and Sir Athelstane Baines, who occupied the same position in 1891, also took part in the proceedings.

The tenth of the series of papers on the Provinces of India was read by Sir John O. Miller. His theme was the Central Provinces, of which he was Chief Commissioner a few years ago. He claimed that what was formerly sometimes called the "Cinderella of the Indian Provinces," has passed the stage at which it can be called backward, and that its people are preparing themselves to play their part in the industrial evolution of India. One of the most eminent of Sir John Miller's predecessors in the Central Provinces—Lord MacDonnell—presided, and the newly-appointed Chief Commissioner, Sir Benjamin Robertson, was one of the speakers. The *Pioneer*, in a recent leading article says:— "The Royal Society of Arts follow the useful practice of bringing the several Provinces of India under periodical review by means of papers contributed by distinguished Indian public servants, who can speak with knowledge and authority . . . We are gradually realising that the study of India as a whole is confusing and profitless, as the study of Europe as a whole would be. A country and not a continent is the preferable unit. There is much more to be learnt from placing one Province under the student's microscope, especially when the Province happens, as in the present case, to contain the contrasts and diversities which characterise India as a whole. Sir John Miller's paper would serve as an admirable introduction to the study of the aims and results of British administration in India."

Mr. Neville Priestley, in an important paper, gave a lucid history of the necessarily varied policy followed by the Government of India in regard to the financing of railways since their inception, and ably discussed the reasons why the opening of the country by means of new lines is at present "practically at a standstill." Owing to many pressing demands on the public purse, the supreme authorities are reduced in the current year to a "Construction Programme" of only fourteen miles (apart from extensions already in hand), and to another sixty or seventy miles from funds furnished by outside agencies, whereas, in Mr. Priestley's opinion, an expansion at the rate of a thousand miles a year is required. One of the remedies suggested in the paper is the making of lines of a less expensive character, a suggestion endorsed by the chairman of the meeting (the Right Hon. Sir Edgar Speyer), who, in the course of a weighty speech, pointed out that in the United States, where railway construction has proceeded in a very remarkable way during the last fifty years, the rule generally has been to build railways lightly, to trust to the development of the country, and later to use the surplus for the completion of the lines. He seemed to think that it might be an inducement to British capitalists, who hitherto have been inclined to ignore India as a field for investment, if, as an experiment, one of the existing lines could be taken over by a private company at a fair valuation and run entirely as a private concern. Everyone present, he added, appreciated the great importance of the subject, and, after listening to the paper, he felt tempted to give the matter more attention than he had done in the past. A most useful discussion followed.

In the autumn of 1908, Dr. Travis Jenkins, a well-known expert, went out to Calcutta to advise the Government of Bengal on fishery matters, and the excellent paper he read before the Section embodies the main results of the investigations conducted by him, at sea and inland, during his stay in India, lasting a year and a half. His experience has convinced him that India urgently needs a Fishery Board, to consist of five members representing the various maritime Provinces. It must, he says, be obvious even to anyone who has lived a very short time in India that its fisheries are neglected, and that it is the duty of the Government to encourage in every way in its power the development of a natural source of food supply, the potentialities of which are enormous.

The remaining paper was contributed by the Rev. Walter K. Firminger, the subject being "The Old District Records of Bengal." For the past five years Mr. Firminger has been engaged in a careful and disinterested study of these records, many of which are in a state of almost final decay. The late Sir W. W. Hunter drew attention to their importance as materials for history, but until recently scarcely any attempt seems to have been made to save the records from ruin. Mr. Firminger's description of what, through the liberality of the local Government, has been done with the records of Sylhet and Rangpur will, it is hoped, stimulate other

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Provincial administrations to adopt similar measures.

III.—Colonial Section.

The series of papers on "The Manufactures of Greater Britain" having proved successful, it was decided at the time to institute another series of a similar character on the principal natural products of the oversea dominions and possessions. In 1909, Mr. A. E. Humphries dealt with wheat; in 1910, the Hon. Sir John McCall (Agent-General for Tasmania) with fruit generally; in 1911, Mr. F. Douglas Osborne with tin; and in the session just concluded Mr. Alan H. Burgoyne, M.P., with viticulture, which, it is believed, will become "one of the most noteworthy and striking industries under the British flag." Mr. Burgoyne's clever paper evoked a spirited discussion, in which some of his conclusions respecting South Africa were challenged by the Chairman (the Right Hon. Sir Walter F. Hely-Hutchinson) and the Trade Commissioner for the Union (Mr. C. du Plessis Chiappini). The interesting fact was mentioned that out of every dozen bottles of wine drunk in this country one bottle comes from Australia. The South African grower, on the other hand, caters more for the local market, apparently finding this more profitable than endeavouring to create an export trade.

Another question of importance to the Union of South Africa, namely, Irrigation, was discussed by Mr. W. A. Legg, M.Inst.C.E., at the meeting held on January 30th, under the presidency of the High Commissioner (the Hon. Sir Richard Solomon). How largely the agricultural future of South Africa must depend upon an adequate extension of its irrigation works is shown by the fact that the country, notwithstanding its extent, greater than the British Isles, France and Italy combined, is still obliged to import immense quantities of foodstuffs, amounting in value to millions of pounds annually. As Mr. Legg showed, the growing of crops with the rainfall alone without artificial watering can only be attempted in some of the more favoured portions of the Union, and these collectively do not form a large proportion of the whole. Much, however, is expected from the Irrigation Bill to be introduced by Mr. Botha's Government during the present session of the Union Parliament, and outlined by the High Commissioner in a forcible speech. Indeed, Sir Richard Solomon expressed the opinion that we may confidently look forward to the time when the Union will not only produce all the foodstuffs necessary for its own population, but will become one of the principal exporters of those articles to the European markets.

One of the merits of the paper read by the Hon. John Greeley Jenkins, on May 21st, is that it enables certain interesting comparisons to be made between railway expansion in the Commonwealth, and the somewhat disappointing state of things in India described by Mr. Neville Priestley a few days earlier. Railways were begun in both countries about the same time, but while Australia, with a population of four and a half millions, now possesses 17,000 miles of lines, India, with a population of 300 millions, has barely double that amount. Another noteworthy feature of the Australian railway system, and one that India is asked to copy as far as possible, is the cheapness of construction. In many States the cost has been less than £2,000 a mile; in West Australia one or two lines are believed to have been made for about £1,000 a mile, the average for the entire country being £9,000 a mile. Like India, Australia suffers from non-uniformity of gauge—there are three different gauges in the Commonwealth—but Mr. Jenkins and the Agent-General for Queensland (Sir Thomas Robinson) both declared that the disadvantages are not so great as is supposed by those unacquainted with the local circumstances. The Under-Secretary of State for the Colonies (Lord Emmott) expressed what seemed to be the general opinion of the meeting that while State-ownership of railways may not be feasible for the United Kingdom, at least within the next few years, Australia has fully justified her adoption of that principle.

An encouraging account of the condition and prospects of British North Borneo was given by Mr. Leonard Lovegrove, one of the officials of the Chartered Company who are administering with so much sagacity that distant Imperial possession. Earl Brassey, who presided, said that although North Borneo cannot be compared with the largest of Great Britain's tropical possessions, it is thoroughly typical of what our brethren are doing elsewhere beyond the sea. A pleasant feature of this meeting was the strikingly effective kinematographic pictures of scenes in Borneo shown by Mr. Cherry Kearton, who visited the island a year ago.

IV.—Cantor Lectures.

There have been five courses of Cantor lectures during the past session, and the subjects have been as varied as usual. The first course was by Professor Vivian Lewes on "The Carbonisation of Coal." In a course of four lectures,

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Professor Lewes gave the whole history of the subject, and described the various methods which have been employed for obtaining from coal the largest amounts of the various products which can be obtained from it, while at the same time utilising, as far as possible, the energy available for the production of motive power. The earlier methods employed in the destructive distillation of coal were, of course, of a more or less crude nature. First of all, the idea was merely to obtain the largest amount of illuminating gas, but gradually the by-products, which it was found were valuable, became a very important consideration, and at the same time the question had to be considered of obtaining the resulting coke in such a form as to render it most useful. Professor Lewes's treatment of the subject was exhaustive, and brought the information down to the latest available point. It is satisfactory to know that the lectures attracted a great deal of attention amongst those interested in the gas industry. They were well attended by a large and attentive audience, and there has been a considerable demand for the reprint of the report of the lectures which appeared in the *Journal*.

The second course was by Dr. Vaughan Cornish, on the subject of Waves. It is to be remembered that the question is one not merely of scientific interest, but that the action of waves has a very practical engineering bearing in relation to such questions as harbour construction, the maintenance of river navigation, and coast erosion, to say nothing of the further question of the construction of embankments for railways and canals. Dr. Vaughan Cornish has given great attention to the theoretical side of the whole subject, and it may be hoped that the lectures which he has given here and elsewhere may be of practical value to the engineer and naval architect.

The third course, by Mr. Loudon Douglas, was devoted to the Meat Industry. The subject was treated in a very full and practical manner, and the three lectures were devoted respectively to the bullock, the sheep, and the pig, with the products obtainable from each.

The fourth course, by Mr. Luther Hooper, was devoted to the subject of Spinning and Weaving, the title being "The Loom and Spindle: Past, Present, and Future." The greater part of the course was devoted to the hand-loom, a machine which is by no means as obsolete as many may think, since it is still in extensive use, not only for domestic application, but for the manufacture of fabrics of a class and character which cannot be manufactured by machinery. The third and final lecture of the course was, however, devoted in large part to the power-loom, and concluded with a very interesting description of a new and modern type of loom, embodying entirely fresh principles, and differing entirely from the ordinary type, which, however much it has been modified and improved, is still of the same essential character as the oldest form of loom known to mankind.

The final course of lectures was by Mr. Noel Heaton, and was devoted to a description of "The Materials and Methods of Decorative Painting." The treatment was of necessity mainly historical, but Mr. Heaton included in the course a consideration of the most recent modifications of fresco, oil painting, tempera, etc.

V.—Howard Lectures.

In addition to the courses of Cantor lectures a course was given under the bequest of Thomas Howard. The lecturer was Captain H. Riall Sankey, and the subject, "Heavy Oil Engines." The lectures, in the main, dealt with the most recent form of internal-combustion engine—the Diesel heavy oil engine. The subject was treated in a very complete manner, the character and construction of the engine in its various types was fully described, and considerable stress was laid upon the important fact that the Diesel engine can employ oil of any character. The lecturer claimed that in its capacity for utilising almost any sort of oil, the Diesel engine had very great advantages over the earlier forms of the internal-combustion engine, which was very sensitive to the class of oil supplied to it. Many other important points were brought out, and on the whole the lectures gave a very clear and exhaustive account of what may be taken as the latest, though not necessarily the best, type of internal-combustion motor.

As not much is now remembered of the founder of the Trust, it may be well to mention that Thomas Howard was born in 1796. After being trained for the business of a manufacturing chemist, he devoted his attention more particularly to the chemistry of steam, with special regard to its employment in the steam engine. His first invention, in 1825, was a vapour engine, the object of which was to dispense with the then cumbrous boilers by injecting water upon a heated surface. In 1840 he joined the King and Queen Iron Works, of which he was senior partner at the time of his death in 1872. During

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his connection with the works he introduced many improvements in the details of the machinery, and conducted many valuable experiments upon wrought iron.

Under his will the Society holds a sum of £500 for the purpose of providing prizes or medals for treatises on steam and other sources of motive power, or of rewarding inventors.

In 1884, the Council came to the conclusion that the best way of carrying into effect the wishes of the testator would be to arrange for the delivery under this trust of series of lectures on some subject dealing with motive power, which might, after their delivery, form a text-book on the subject. They have, therefore, from time to time, as the accumulated funds permitted, arranged for courses of Howard Lectures, dealing with subjects which seemed to be comprised within the terms of the bequest. Six such courses have already been delivered, and it is hoped that in future years these may be followed by others of equal value.

VI.—Juvenile Lectures.

A good many years ago Mr. Charles Vernon Boys delivered before the Royal Institution a course of lectures on Soap Bubbles, on which was founded his well-known book on the subject. Since the date of those lectures, Mr. Boys has been continually working at the same subject, and the lectures which he gave before this Society during the last Christmas holidays, while partly covering the same ground as the older series, introduced a great deal of fresh material which the lecturer has since accumulated—material which has involved the production of a new edition of "Soap Bubbles." There is no need to follow Mr. Boys through his course of two lectures, or to say how fully they were illustrated, and how greatly the experimental illustrations were appreciated by the audience.

VII.—Albert Medal.

The Albert Medal for the current session has been conferred, with the approval of H.R.H. the Duke of Connaught, President of the Society, upon the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S., "For his services in improving the railway communications, developing the resources, and promoting the commerce and industry of Canada and other parts of the British Empire."

In making this award the Council have desired to mark what they believe to be the national appreciation of the public services which Lord Strathcona has rendered, not only to the Dominion of Canada, but also to the whole Empire, public services which have now extended over a life of more than ninety years.

It is as the founder of the Canadian Pacific Railway that Lord Strathcona is best known to his contemporaries, and will be best remembered by posterity, for it was his energy and financial skill which enabled the project to be carried through at a time when there seemed little prospect of a successful result. The record of the services, social, political, and philanthropic, rendered by him to the country which he entered as a lad in the employment of the Hudson's Bay Company, is a very long one. He has been a munificent benefactor of such institutions as the McGill University and the Victoria Hospital at Montreal, erected by him in commemoration of Queen Victoria's Jubilee, and he has always been ready to provide for the needs alike of Canada and of the Empire, from the time when, during the Red River outbreak, he supplemented the forces of the Dominion with a troop of horse raised at his own cost, down to that of the Boer War, when he provided the entire cost of the corps of 600 mounted men, known as Strathcona's Horse, which was raised in Canada and transported to South Africa without any cost to the Imperial Government.

VIII.—Medals.

The Council have awarded the Society's Silver Medal to the following readers of papers during the Session 1911–12.

At the Ordinary Meetings :—

Algernon E. Berriman, "The Efficiency of the Aeroplane."

Professor G. W. Osborn Howe, M.Sc., M.I.E.E., "Recent Progress in Radio-Telegraphy."

Cecil Thomas, "Gem-Engraving."

H. A. Roberts, M.A., "Education in Science as a Preparation for Industrial Work."

F. Martin Duncan, "The Marine Biological Association, and some account of the Work it has accomplished."

Theodore E. Salvesen, "The Whaling Industry of To-day."

George Fletcher, "Technical Education in Ireland."

E. D. Morel, "British Rule in Nigeria."

Ernest Kilburn Scott, Assoc.M.Inst.C.E., M.I.E.E., "The Manufacture of Nitrates from the Atmosphere."

In the Indian Section :—

J. Travis Jenkins, D.Sc., Ph.D., Superintendent of Lancashire and Western Sea Fisheries, "Fisheries of Bengal."

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E. A. Gait, I.C.S., C.S.I., C.I.E., Census Commissioner for India, "The Indian Census of 1911."

Sir John O. Miller, K.C.S.I., "The Central Provinces."

Neville Priestley, Managing Director, South Indian Railway, "Indian Railways."

In the Colonial Section:—

W. A. Legg, M.Inst.C.E., "Irrigation in South Africa."

Alan H. Burgoyne, M.P., "Colonial Vine Culture."

Of recent years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society. Acting on this rule the Council were precluded from considering the following papers:—

At the Ordinary Meetings:—

James Douglas, LL.D., "The Industrial Progress of the United States of America"; Cyril Davenport, F.S.A., "Illuminated MSS."; Leonard Hill, M.B., F.R.S., "The Influence of Ozone in Ventilation"; Frank Warner, "The British Silk Industry and its Development since 1903"; T. Thorne Baker, "Some Modern Problems of Illumination—the Measurement and Comparison of Light Sources"; William Burton, M.A., F.C.S., "Ancient Egyptian Ceramics."

In the Indian Section:—

Colonel Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., D.Sc., "The North-East Frontier of India." Sir Thomas Holdich was also disqualified by the fact that he is a member of Council.

In the Colonial Section:—

The Hon. John G. Jenkins, "Australian Railways."

The Council, however, desire to express their high appreciation of these papers.

IX.—Owen Jones Prizes.

After the death, in 1874, of Owen Jones, the well-known decorator and writer on decoration, a committee was formed to collect subscriptions for the purpose of founding a memorial, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, etc., regulated by the principles laid down by Owen Jones." The prizes have now been awarded annually since the year 1878 on the results of the annual competition of the Science and Art Department, and its successor, the Board of Education.

Six prizes were awarded last session (1910–11), each prize consisting, in accordance with the regulations prescribed for the administration of the Trust, of a bound copy of Owen Jones's "Principles of Design," and a bronze medal.

The list of the successful candidates has already appeared in the *Journal.**

The examiners who judged the works submitted for competition report as follows:—

"587 works were sent in for this competition, showing an increase of 146 on last year, and the general level of merit is higher than then.

"The best examples are the Woven, Printed, and Stencilled Fabrics. There is a fairly good representation of the useful class of Damasks, as well as some good Carpets and Embroidery.

"The Examiners regret to find that no examples of Designs for Furniture have been submitted."

As already announced, the next award will be made in the current year. Six prizes have already been offered for competition.

X.—North London Exhibition Trust.

For some years past the interest on the sum of £157, the surplus of the North London Exhibition held in 1864, has been devoted to the award of prizes to students of the Artistic Crafts Department in the Northampton Polytechnic Institute, Clerkenwell. At present an annual sum of £5 is placed at the disposal of the Governors of the Institute. Of this amount £4 only was expended last year, so that a sum of £6 was available for the present year.

The names of the successful candidates were published in last week's *Journal.* The awards have been made on the recommendation of Mr. Alan S. Cole, C.B.

XI.—Examinations.

In the paragraph dealing with the examinations of 1911 in last year's report, it was stated that the Council were considering very carefully what steps they could take to ensure the absolute integrity of the Society's examinations, and to prevent a repetition of that most unfortunate occurrence of last year, when certain teachers were successfully prosecuted for fraudulently obtaining the Society's medals. The Council are glad that they are now able to report that so far at all events as London is concerned, they believe that this object has been attained by their good fortune in securing the valuable aid of the London County

* See *Journal*, September 29th, 1911.

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Council Education Committee in the superintendence of the examinations.

As the members are aware, the Society's examinations for the past fifty years have been conducted through the agency of voluntary committees, and it was always felt that these committees could be relied upon for the strict supervision of the examinations. But, to quote a paragraph from last year's report, "the development and competition between the various proprietary institutions which have sprung up of late years, and which it may be added are doing very efficient service in the cause of education, has produced a source of temptation amongst those interested in such institutions, who are anxious to obtain all possible credit for their own schools, and may occasionally be led away to attempt to obtain such credit by illegitimate means." Small as are the temptations to such an illegitimate course, it is yet certain that the stress of competition has occasionally led to fraudulent proceedings. A few such in previous years have been detected and suppressed. Last year it was found necessary to take public action, and this action had the satisfactory result at all events of vindicating the Society's good faith. But so long as the whole supervision of the examinations is in the hands of unofficial committees, who are of necessity associated with the institutions where the examinations are held, it cannot be denied that even though, as is certainly the case, nearly all such committees are far above suspicion, the public cannot be expected to place the same implicit reliance in the results of the examinations as if they were conducted under the supervision of some independent authority.

Negotiations were for some time carried on with the London County Council Education Committee, which is the education authority for the County of London, but it was not until after a good deal of inquiry and considerable discussion that the Committee saw its way to agree with the Society's request. Eventually they did so, and with most satisfactory results. The final conclusion was not reached until a very short time before the date of the examinations, and consequently the arrangements were made under a certain amount of pressure. Nevertheless they worked with perfect smoothness, and it may be said that they gave entire satisfaction to all concerned. This, of course, is not to say that there were not a few complaints of individual hardship; but these were merely infrequent exceptions to the general satisfaction.

The actual changes in the administration were really not considerable, and in no way affected the candidates themselves. The various local committees were asked to send their applications to the L.C.C. Education Office, instead of to the office of the Society. The places where the candidates were to sit for examination were then allotted by the Committee. All the larger centres took their own candidates. The smaller centres were amalgamated, and a certain amount of administrative work was thus saved. The most important change really was that the superintendents for the examinations were appointed by the Committee, and were responsible to it, so that the examinations were for the first time in London conducted under the superintendence of independent officers unconnected with the institutions where the examinations were held. The necessary additional cost was this year borne by the Society's funds; but notice was given that for future years it would have to be provided by a small fee to be paid by the local committees. It is difficult to see that any objection can be raised to this, because the local committees were this year relieved from the cost of providing and paying their own superintendents.

The Council desire to express their appreciation of the assistance which they have received from the London County Council, and their belief that its co-operation will add considerably to the value of the examinations, and to the public appreciation of the certificates awarded to the candidates. A similar co-operation has, of recent years, been arranged between the Society and a large proportion of the educational authorities throughout the country, who have established centres of their own, and have in many cases absorbed previously existing local committees. It is the earnest hope of the Council that this system, which has been steadily increasing during the past few years, may still further develop, and that, especially in the great provincial cities, the educational authorities will fall into line with the London County Council, so that, before long, the Council may be able to report that the whole of the Society's examinations are conducted under official and independent authority.

The large number of candidates entering for the Society's examinations, and the consequent extension of time before the results can be published, have for some years past rendered it necessary to postpone till a later date any detailed report on the examinations of the year. A few figures may be given. The total number

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of papers worked was 34,006, the number last year being 34,242, a decrease of 236. These were divided among the various stages as follows:—Stage I., 14,936; Stage II., 13,583; Stage III., 5,487. The corresponding figures for 1911 were:—Stage I., 14,286; Stage II., 14,025; Stage III., 5,931.

As usual, further information will be provided in a general report on the examinations which will be published as soon as convenient after all the results have been made public. These results, so far as concerns Stage III. (Advanced) have just been published. The results of Stage II. (Intermediate) will be issued in July, and those of Stage I. (Elementary) in August.

XII.—Practical Examinations in Music, 1911.

The Practical Examinations in Music were not concluded last year until July 10th, 1911, too late for the results to be included in the Report of the Council. They lasted for seven days.

The examinations were conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 289 candidates entered, and of these 283 were examined, a decrease of 56 as compared with 1910. There were 214 passes and 69 failures.

The following were the subjects taken up:—Piano, singing, violin and violoncello. 239 entered for the piano, 182 of whom passed; 37 entered for the violin, of whom 28 passed; 4 entered for the violoncello, 3 of whom passed; 3 entered for singing, of whom only 1 passed. One medal was awarded.

The quality of the competitors was, on the whole, much the same as usual.

XIII.—Practical Examinations in Music, 1912.

The Practical Examinations for the present year commenced on the 22nd inst., and will be finished on July 3rd, after which a summary of the results will be given in the *Journal*. The work of the examination is being carried out by the same examiners as in the last nine years; 300 candidates have entered for the present examinations, an increase on last year of 11.

XIV.—Viva Voce Examinations in Modern Languages.

Up to the present date twenty-four examinations have been held this year in London, Liverpool, and Manchester. Arrangements have also been made for holding examinations at several other centres.

At these examinations 545 candidates presented themselves, of whom 451 passed (182 with distinction) and 94 failed. The languages taken up were French, German, Italian, and Spanish.

The results of previous years are as follows:—

Year.	Number Examined.	Passed.	Failed.
1902	280	202	78
1903	456	324	132
1904	540	375	165
1905	681	502	179
1906	644	469	175
1907	629	476	153
1908	615	467	148
1909	656	506	150
1910	642	495	147
1911	583	463	120

It is satisfactory to note that, if the numbers of candidates do not increase, the standard shows a steady improvement, as the proportion of failures regularly diminishes.

These examinations are held at any of the Society's centres where the necessary arrangements can be made, at any date convenient to the local committee. The examination includes dictation, reading, and conversation, and is so arranged as to test efficiency in a colloquial knowledge of the language, without laying too much stress on minute grammatical accuracy. Candidates who are reported upon as highly qualified by the examiners receive a certificate of having passed with distinction.

The examiners are Mr. S. Barlet and Mr. B. M. Nevill Perkins for French, Professor H. G. Atkins and Professor A. Johannson for German, Mr. J. M. Villasante and Mr. W. F. Bletcher for Spanish, and Mr. Luigi Ricci for Italian.

XV.—The Society's Medal.

It was mentioned in the last Council Report that H.M. King George V., on becoming Patron of the Society, had graciously consented that his head should be engraved on the medal, and had expressed the wish that the work should be carried out by Mr. Bertram Mackennal, A.R.A.

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The die was prepared from Mr. Mackennal's model by Mr. Allan Wyon, and the new medal is a fine example of artistic workmanship, and also an admirable likeness of the King. The first medal struck was presented to his Majesty, who intimated his warm approval of it.*

During the first century of the Society's existence many medals were used. Perhaps the most beautiful of these was the one designed by Flaxman in execution of the idea suggested by James Barry that the Society's principal medal should have on it the heads of Minerva and Mercury. This medal was executed in 1807, and in that year the first example of it was presented to the designer.

In 1849 the idea was suggested that the medal should bear the head of the President, and permission having been obtained from H.R.H. Prince Albert, who was then President of the Society, a die for the purpose was made by W. Wyon. This medal was employed up to 1861. After the election of King Edward VII., then H.R.H. the Prince of Wales, to the Presidentship in 1863, his head was placed upon the obverse of the medal, the die being also made by W. Wyon. In 1900, the old die being worn, a new die was engraved at his Majesty's desire by Mr. Emil Fuchs. In 1901, when King Edward succeeded to the throne, and became Patron of the Society, he acceded to the request of the Council that his head should still appear on the Society's medal, and this was done, the necessary alteration being made in the inscription. This medal was used until King Edward's death in 1910.

XVI.—Soane Museum.

Under the Act by which the affairs of the Soane Museum are regulated, the Royal Society of Arts have to nominate one of the trustees. The office is held for five years, and the last election having been in 1907, it is necessary that the Society should exercise its power during the present year. The Council recommend for election Sir George Birdwood, who has acted for the last fifteen years, having been first elected in 1897.

In 1833 Sir John Soane presented to the nation the house which he had built in Lincoln's Inn Fields, and in which he had placed his very valuable collection of pictures and objects of antiquarian interest, together with his extensive library. At the same time he obtained an Act of Parliament by which the property was vested in trustees—four appointed by himself, and five by the Corporation of London, the Royal Academy, the Royal Society, the Society of Antiquaries, and the Society of Arts—the four original nominated trustees having the power to fill up by election vacancies in their number as they occurred. The authority of all the trustees is the same, but the property is vested in the life trustees, and they only have the power of signing cheques. Sir John Soane also provided the funds necessary for the maintenance of the house as a Museum. He died on January 20th, 1837, and shortly afterwards the Museum was placed under the authority of the trustees.

The following is a list of the trustees appointed by the Society—

1837 to 1843—H.R.H. the Duke of Sussex, President of the Society.
1844 to 1857—H.R.H. the Prince Consort, President of the Society.
1857 to 1864—Sir Charles Wentworth Dilke, Bart.
1865 to 1876—Samuel Redgrave.
1876 to 1882—Alan S. Cole, C.B.
1882 to 1896—Sir Benjamin Ward Richardson, M.D., F.R.S.
1897 to 1912—Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

XVII.—Conversazione.

The Council decided to abandon the holding of the Conversazione this year, and to hold it in future every other year instead of annually. The attendance of late has been much smaller than in former years, when meetings of this sort were less common, and in practice it was found that only a small proportion of the members availed themselves of the privilege. The Council trust, therefore, that their action has met with the approval of the members generally.

XVIII.—History of the Society.

The series of articles on the Society's history, which were commenced by the Secretary in the last volume of the *Journal*, have been continued. In all, eleven articles have now appeared, and they bring the history down to the time when the Society obtained a Charter of Incorporation —1847. It is expected that the series may before long be completed, and it is intended to republish them in the form of a book, which it is hoped may supply the need of a complete history of the Society, since its foundation more than a century and a half ago.

XIX.—New Council.

In accordance with the by-laws regulating the election of the Council, four vice-presidents and four ordinary members of Council retire annually. The four retiring vice-presidents, all

* An illustration of the medal was given in the *Journal* for October 20th, 1911.

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of whom go out by seniority, are the Earl of Cromer, Sir William Preece, Sir Boverton Redwood, and Sir William White. The four retiring members of Council, partly in consequence of seniority and partly by infrequency of attendance, are Sir George Askwith, Sir Thomas Holdich, Mr. James Swinburne, and Sir Philip Watts.

One retiring member of Council is eligible for election as a vice-president, and the Council have therefore nominated Sir Thomas Holdich to serve in that capacity. The other new vice-presidents submitted for the consideration of the members are Sir William Abney, who has served in previous years, and was Chairman of the Council in 1903–5, and also Lord Cowdray and Sir Henry Mortimer Durand, neither of whom has held office on the Council before.

The new members of Council proposed are Major Percy MacMahon, Sir Philip Magnus, Mr. Alan Campbell Swinton, and Professor Unwin. Sir Philip Magnus is the only one who has previously served on the Council. Major MacMahon is Deputy Warden of the Standards at the Board of Trade, Mr. Campbell Swinton is a well-known electrician and man of science, and Professor Unwin is the eminent engineer, who at the present time fills the office of president of the Institution of Civil Engineers.

As Professor J. M. Thomson has served for five years as a treasurer, the time of his office has expired. In his place the Council put forward the name of Sir William White, one of the retiring vice-presidents.

XX.—Obituary.

The list of losses which the Society has suffered by death is much shorter than usual, and contains less than the usual proportion of distinguished names. One member of the Council died during the session, Dr. Henry Taylor Bovey, who, after a distinguished educational career at McGill University, Montreal, returned to this country in 1909 to take up the post of Rector of the Imperial College of Science and Technology, a duty which the breakdown in his health prevented his discharging for more than a few months. Mr. James S. Neville served on the Council from 1896 to 1898, and on the Indian Section Committee from 1896 to 1901. His name was originally White, and he was a brother-in-law of the late Dr. Mann, who was for many years Secretary of the African Section of the Society. The Earl of Onslow, who had been a member since 1903, had on two previous occasions presided at meetings of the Colonial Section. Sir Francis Powell, a distinguished Conservative Member of Parliament and Churchman, was amongst the oldest members of the Society, which he joined in 1854. Sir John Grinlinton, long associated with Ceylon, for which island he was Commissioner at the Chicago Exhibition in 1893, was a member of the Society's Colonial Section Committee, but of recent years his great age prevented his taking any active part in its work. Sir Charles Bennet Lawes-Wittewronge, son of Sir John Bennet Lawes the famous agriculturist, was well known to Cambridge men of his time as a celebrated athlete, and later acquired considerable reputation as a sculptor. The Maharaja of Cooch-Behar died during his visit to England for the King's Coronation. He was an admirable representative of the ruling chiefs of India, and a constant visitor to England. Sir William Crossley, who with his brother founded the great engineering firm of Crossley Brothers, became a member of the Society in 1884. The work the firm did in the manufacture and introduction of the gas engine was recognised by the award of one of the medals offered by the Society at the International Inventions Exhibition in 1885. Sir James Buckingham, long resident in Assam, was recognised as a high authority on all matters affecting the tea industry. Sir Julius Wernher, the well-known South African millionaire, who devoted so much of his wealth to the advancement of education, joined the Society in 1899. Sir William Zeal, an eminent Victorian politician and at one time Postmaster-General for the State, had been a member of the Society since 1897. Mr. Thomas Colby was at the time of his death the oldest member of the Society, which he joined in 1850. Mr. Henry Oppenheim, for many years a banker and afterwards well-known as a collector of objects of art, was an old member of the Society, which he joined in 1875. Mr. Julius Weinberg was of still longer standing, as he was elected in 1861.

Amongst other names which should be mentioned are Mr. James Aitchison, the well-known optician; Mr. George Wedlake, for long a regular contributor to the *Journal*; Mr. Albert Chancellor, at one time Master of the Coachmakers' Company and Mayor of Richmond; and Mr. G. E. Pritchett, who was at one time a very constant attendant at the Society's meetings.

Notices of the above-named, and of other members of the Society who have died during

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the past year, will be found in the columns of the *Journal.*

XXI.—FINANCE.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the assets and liabilities of the Society, its investments and the trusts standing in its name.

THE CHAIRMAN (Lord Sanderson, G.C.B.), in moving the adoption of the Report, said it was satisfactory to know that the Society was in a good financial position. It was, however, by no means opulent, and they were not in a position to award the large money premiums which it was the practice to grant in the past. As regards the papers and lectures during the past session, he felt sure that they were quite as interesting and as wide in their scope as in any previous year. They had dealt with most of the questions interesting the public at the present time, including radio-telegraphy, aviation, ventilation, coal supplies, oil engines, meat and textile industries, and also with a question of vital importance to great cities—that of passenger transportation. Besides these, they had had two papers dealing with technical education, and it was satisfactory to note, as evidence of our progress in this respect, that at the present time there were schools in this country to which Continental students came to be instructed. The papers dealing with art subjects had been illustrated with lantern-slides of the greatest beauty, whilst the paper on "The Industrial Progress of the United States" was very remarkable and suggestive. The papers read in the Indian and Colonial Sections extended over a very wide field: one on "The North-East Frontier of India" dealt with a new phase of policy—the question of our relations with China on the Indian frontier. The Juvenile lectures by Mr. Vernon Boys on "Soap Bubbles" would be remembered with vivid pleasure by all who had attended them. He thought the members of the Society were indebted to Sir George Birdwood, too, for his contribution to the *Journal* on the subject of that mystic emblem of pre-historic times—the Svastika. Referring to the examinations of the Society, he said it was quite clear that the value of the medals and certificates awarded by the Society depended a great deal upon the public being assured of the integrity of the examinations, and he thought the Society was to be congratulated on having secured the co-operation of the Education Committee of the London County Council in the superintendence of the examinations held in the County of London. At certain large provincial centres also the examinations were under the supervision of the local educational authorities, and he hoped, before long, that their example would be followed throughout the United Kingdom. He felt sure that any slight increase in expenditure necessary to carry out the work was quite worth while. The increase in the number of candidates taking up foreign languages showed that the British public were realising how essential it was to have a knowledge of Continental languages. He thought their thanks were due to the Secretary for the valuable articles he had contributed to the *Journal* on the Society's early history. They had been extremely interesting, and had brought to light a point known to very few people—that not only had the Society done a great deal to promote all forms of art and industry, but it had also helped in the formation of other societies, who had taken up special branches of work. It would be noted, for instance, that the Society was the first to establish exhibitions of contemporary pictures, and that it also was instrumental in the foundation of the Royal Academy. There was, however, a large field of work still left to the Society to deal with.

LORD BLYTH, in seconding the adoption of the Report, felt sure that the members would agree with him in saying how much they were indebted to the Chairman of Council, as well as to the Secretary, for the services they had rendered the Society during the past year. He thought there was no institution that had done so much work for the good of the Empire as the Society of Arts has done since its foundation a century and a half ago. The Society could not be engaged in better work, and it was their duty at the present time to keep the country well to the front. He had been reminded that members would be doing a real and lasting service by asking their friends to remember the Society when drawing up their wills. It would greatly help the Society to carry on and extend the scope of its work, and he was confident that their bequests could not be put to a better purpose. He had the greatest pleasure in seconding the adoption of the Report.

SIR ARUNDEL T. ARUNDEL, K.C.S.I., asked whether it would be possible for the articles on the "History of the Society" to be reprinted, as this, he thought, would add greatly to their interest.

THE CHAIRMAN said as soon as the series was complete it was proposed to publish the articles in book form. Such a volume would be useful in many ways, and he was sure the members would endorse the action of the Council in promising that any assistance necessary should be given towards the production of the History.

The adoption of the Report was then agreed to.

THE CHAIRMAN proposed a cordial vote of thanks to Sir Henry Trueman Wood (the Secretary), Mr. G. K. Menzies (the Assistant Secretary), Mr. S. Digby (the Secretary of the Indian and Colonial Sections), Mr. George Davenport (the Chief Clerk), and Mr. J. H. Buchanan (Accountant), and to the other officers of the Society for their services.

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Mr. Robert Kaye Gray said it gave him very great pleasure to second the resolution, which was carried unanimously.

The Secretary returned thanks for this expression of confidence in himself and in the other officers of the Society. He also returned thanks for the kind references which had been made to his work in connection with the Society's early history. He hoped when the articles came to be published in book form that they would be useful in spreading information about many matters connected with the Society which were not generally known to the public.

The ballot having remained open for half an hour, and the scrutineers having reported, the Chairman declared that the following had been elected to fill the several offices. [The names in *italics* are those of members who have not, during the past year, filled the office to which they have been elected.]

President.

H.R.H. The Duke of Connaught and Strathearn, K.G.

Vice-Presidents.

Duke of Abercorn, K.G., C.B.
Sir William Abney, K.C.B., D.Sc., D.C.L., F.R.S.
The Lord Chief Justice of England, G.C.M.G., F.R.S.
Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.
Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.
Lord Blyth.
Lord Cowdray.
Sir Henry Hardinge Cunynghame, K.C.B.
Right Hon. Sir Henry Mortimer Durand, G.C.M.G., K.C.S.I., K.C.I.E.
Hon. Sir Charles W. Fremantle, K.C.B.
Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
Earl Curzon of Kedleston, G.C.S.I., G.C.I.E.
Sir John Cameron Lamb, C.B., C.M.G.
Sir William Lee-Warner, G.C.S.I., LL.D.
Hon. Richard Clere Parsons, M.A.
Sir Westby B. Perceval, K.C.M.G.
Sir Owen Roberts, M.A., D.C.L.
Earl of Rosebery, K.G., K.T., D.C.L., F.R.S.
Lord Sanderson, G.C.B., K.C.M.G.
Alexander Siemens.
Hon. Sir Richard Solomon, K.C.B., K.C.M.G., K.C.V.O., K.C.
Sir William Hood Treacher, K.C.M.G.
Sir John Wolfe-Barry, K.C.B., LL.D., F.R.S.

Ordinary Members of Council.

Dugald Clerk, F.R.S.
Alan Summerly Cole, C.B.
William Henry Davison, M.A.
Robert Kaye Gray.
Colonel H. C. L. Holden, R.A., C.B., F.R.S.
Major Percy A. MacMahon, R.A., Sc.D., LL.D., F.R.S.
Sir Philip Magnus, M.P.
William Henry Maw, LL.D.
Sir Henry A. Miers, D.Sc., F.R.S.
Alan A. Campbell Swinton.
Prof. William Cawthorne Unwin, LL.D., F.R.S.
Colonel Sir John Smith Young, C.V.O.

Treasurers.

Carmichael Thomas.
Sir William H. White, K.C.B., LL.D., Sc.D., F.R.S.

Secretary.

Sir Henry Trueman Wood, M.A.

Soane Trustee.

Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

On the motion of the Chairman a vote of thanks to the scrutineers was carried unanimously.

Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., proposed a hearty vote of thanks to Lord Sanderson, not only for presiding on the present occasion, but for his conduct in the chair during the past year. He thought the Society were very fortunate in securing Lord Sanderson as their Chairman. They could not have had a more fully informed or more successful Chairman, and considering the demand for Lord Sanderson's services, they ought to congratulate themselves on having his lordship to preside over the Society.

The motion was seconded by the Hon. Richard Clere Parsons, who wished to add his testimony to the interest Lord Sanderson had taken in the affairs of the Society. The duties of Chairman of Council were by no means easy, but the attention his lordship had paid to all matters connected with the Society was remarkable.

The Chairman acknowledged the vote of thanks.

The meeting then adjourned.

THE EXHIBITION OF DESIGNS FOR MURAL PAINTING AT CROSBY HALL.

An exhibition of this kind is bound to be more or less unsatisfactory by the very nature of things, for designs intended for the decoration of a building if properly suited to their purpose cannot show to advantage when exhibited after the manner of pictures, apart from their proper surroundings, and care must be exercised, in judging the merits

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of a design, to make allowance for the problem that has to be solved in its actual execution. The inherent danger of an exhibition of such work is, in fact, that of focussing too much attention on the actual details of the design as an independent work, whereas it is a truism that its proper function is to form part of the scheme of the building in which it is placed.

One might almost say that the chief value of this exhibition lies in the fact that it brings into prominence how far modern art has departed from this ideal, as a consequence of the prevailing tendency to work for exhibition and the concentration of art teaching on the technique of oil painting. With only too few exceptions the works exhibited may be described as Academy pictures adapted as mural paintings, and it is clearly evident that there is no live tradition of mural decoration in the highest sense of the term.

The exhibition contains two classes of exhibits—a loan collection of designs for works actually executed at various times, and designs submitted in competition for the various commissions offered under the scheme promoted by the Mural Exhibition Committee.

Of the former, many are well-known examples of modern mural paintings, by Walter Crane, Henry Holiday, Frederick Shields, Ford Maddox Brown, and other modern artists. It is interesting to compare these exhibits with the few examples of the work of an earlier generation, such as the sketch for mosaic work by J. C. Hook, R.A., and to note the progress that has already been made in our own times towards the revival of the true principles of mural decoration. It is still more interesting to study the reproduction of English mural paintings of the thirteenth century exhibited by Mr. W. Tristam, and to notice the charming results produced by simple treatment and in despite of limitations in the way of drawing.

The special feature of the exhibition is the collection of competition designs by students. Briefly outlined, the scheme under which these have been produced, and of which the exhibition is an outcome, has the dual object of encouraging students to study the principles of mural painting and of providing them with the necessary opportunities for the execution of such work.

A large and influential committee was formed for the purpose, with Mr. Charles Aitken and Mr. Wilfred Walter as secretaries, and as a result of their work various sites were offered for decoration and funds provided for the execution of approved designs. The work submitted in competition for these commissions is the work of students and must be judged as such, but, as already remarked, the prevailing impression one gathers from their examination is that there is a general lack of appreciation of the problems that have to be faced. There is a tendency to elaboration of detail and concentration on perspective and light and shade, and an absence of the broad and simple treatment essential for the design to harmonise with the building in which it is placed and stand the test of being viewed in all lights and from all distances. This is a tendency one would expect to find as the result of modern training, which is largely based on painting for exhibition, but it is a tendency which must be overcome if really satisfactory mural painting is to be produced in the future.

One can find less excuse for those who exhibit designs which rush to the opposite extreme, and mistake crudeness of drawing and ill-considered execution for simplicity and breadth of treatment. Above all things what is wanted in mural decoration is common-sense, and the introduction of the bizarre and extravagant cannot be too strongly deprecated. The exhibitors we have in mind at the moment seem to have been under the impression that to be simple one must copy the archaic. One has only to compare the designs produced with the reproductions of early work alluded to above to see the fallacy of such reasoning. They have copied the letter and more particularly the faults of mediæval work, but failed to catch the spirit under which it was produced.

One can, of course, only refer to the matter in general terms in this note—it must not be imagined from this general criticism that, taken in detail, there are not many signs of promise. This exhibition is the first of its kind; it will inevitably direct attention to the needs of mural painting and one hopes that considerable progress may result. Some of the results of the competitions have been announced. Three commissions of £100 each were offered for approved designs for the New Gallery of Modern Art at Dublin, the selection to be made by the donor. The designs selected are by Mr. Walter Bayes (No. 28, "Irish Linen"), Mr. Cayley Robinson (No. 23, "The Coming of St. Patrick"), and Mr. James Mark Willcox.

The grant of £100 offered by Mr. Davis for the decoration of the vestibule of the Middlesex Hospital has not been awarded, but £50 has been granted to Mr. Maclaren for his design. The competition offered by the London County Council for the decoration of the school halls at Cable Street and Commercial Street has been won by Miss Jacobs (No. 84, "Prince John Granting the Commune"), and Mr. S. H. North (No. 34, "St. George and the Dragon").

On Tuesday evening, the 18th inst., a meeting was held at the Exhibition under the auspices of the Society of Mural Decorators and Painters in Tempera (which has been recently reorganised with the avowed object of studying the materials and methods of mural decoration and the improvement of the arts of painting in tempera and painting in fresco), when Sir Charles Holroyd presided over a large audience.

Professor Selwyn Image spoke on "The Future of Mural Decoration" pointing out the various problems that had to be solved and difficulties that had to be faced by the movement to ensure its success.

Mr. Walter Crane pleaded for more courage and

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enthusiasm in grappling with the difficulties and finding the right path, and Mr. Southall, Mr. A. S. Penty, Mr. J. D. Crace, Mr. Halsey Ricardo, Mr. Hallward, and Mr. Noel Heaton contributed to the discussion.

Owing to the interest that has been aroused in this exhibition it has been decided to continue it until the 29th inst. instead of closing on the 22nd inst., as originally arranged.

LORD KITCHENER ON EGYPT AND THE SUDAN.

Lord Kitchener's return to Egypt, after an absence of eleven years, has been now marked by the issue of a report whose general interest is enhanced not only by the attention which he draws to the more important developments effected in the interval, but also by the special part that Egypt plays in the present political position. Almost simultaneously with the British Agent's arrival in the country, the whole situation in the Mediterranean and Northern Africa was rudely disturbed by the Italian invasion of Tripoli and Cyrenaica, which naturally produced much excitement among the Mohammedans. Formerly the more intelligent of these inhabitants constituted a fairly homogeneous body based on fixed social laws, but nowadays, Lord Kitchener remarks, the collective community is split up and divided into parties and factions of a political character, which, in contrast with the party systems of Western life, are inapplicable to Eastern traditions, and do nothing to elevate or develop the intelligent character of an Oriental race.

The future progress of the Egyptians depends on improved methods of agriculture, combined with general education, and this end is powerfully furthered by the newly-formed Agricultural Department of Government, who impart instruction and advice to cultivators, and are establishing experimental farms throughout the country. The fellah remains the same as he has always been, one of the best and most hard-working types of humanity, though somewhat conservative and hardly realising the changes taking place around him. It is difficult for a people who have through many ages always striven for more water, to realise that too much of a good thing may be detrimental. Hence among the more urgent needs of the day are drainage works, to reclaim water-logged areas, increase of cattle, which have decreased through disease to the extent of a quarter of a million animals during the last seven years, a more careful selection of cotton-seed, and new types to replace the old, which have deteriorated. To provide the latter wants, cotton-breeding has been energetically taken up, and Government now supplies the fellah with better seed for planting. With damp, undrained soil, and the indiscriminate destruction of bird life in recent years, the cotton pests have increased enormously and commit frightful ravages on the crops. A commission is sitting under the presidency of Prince Hussein Pasha, and experimenting to discover some practical means of destroying these insects. The monumental work of the Assuan dam is now practically completed, and the immense benefits accruing by the increased irrigation of the country will repay the expenditure many times over.

The indebtedness of the fellah has always been a source of grave economic anxiety, and it is hoped that the spread of elementary education and the extension of savings banks to the villages may eventually enable the cultivator to clear himself of debt. The establishment of cotton markets throughout the country, and the posting of the daily prices of cotton, will conduce to the fellah deriving a better remuneration for his labour.

In 1910 the important experiment was put in hand of transferring the business of education to the provincial councils, funds being provided by a percentage on the land taxes. The councils have taken up the work with enthusiasm, and the result is that a great impulse has been given to education. Formerly, when the conditions of life were still simple, illiteracy was not perhaps felt as a serious drawback, but modern changes have brought the agriculturist, trader, and workman increasingly into contact with the more highly educated sections of the people, and placed them where illiteracy is an ever-growing disability. The Government have shown their confidence in this new system of local education by a grant of £E100,000 to assist the councils in their work of building and equipping schools, which will probably help to make the widespread illiteracy of the fellah a thing of the past.

Two other interesting developments in the educational policy of the country consist (1) in the commencement of a system of commercial education, which will throw open to Egyptians many honourable and lucrative positions in civil life hitherto closed to them, and (2) in the institution of a proper system of civil service examinations for entrance into the Government service, a step which will both raise the intellectual standard of the officials and remove any suspicion of favouritism which, however unjustly, may have existed.

The clog to progress formed by the Capitulations has been often dwelt upon by Lord Kitchener's predecessors, and is only referred to generally in the present report. As to the mixed tribunals, there is no doubt that they are no longer adequate to cope with the large volume of civil and commercial business coming before them. The remedy, in Lord Kitchener's opinion; would appear to lie to a great extent in the reduction of the number of judges necessary to form a chamber, but owing to the difficulty in getting the Powers to agree to reforms nothing can, unfortunately, be done in this direction. With reference to the native tribunals, considerable progress has been made during the last few years, and justice is generally administered by the natives with efficiency and despatch, foreigners often assigning their claims to natives in order to get them dealt with rapidly in the native courts.

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With regard to the affairs of the Sudan, the visit of the King and Queen to Port Sudan in January, though not actually falling within the events of 1911, naturally calls for notice, largely in consequence of the excellent effect which the visit produced throughout the country. After the departure of their Majesties, the sheiks and notables assembled at Khartoum to discuss the affairs of the Sudan with Government officials, and it was very evident from their conversation how greatly they had been impressed by the auspicious event.

The population of the Sudan is now estimated at well over three millions, a satisfactory increase over the two millions to which it had been reduced by the fanatical rule of the Mahdi and his successor, coupled with the wars, disease, and starvation brought in its train. From surrounding parts of Africa a constant stream of immigrants, attracted by the peaceful and prosperous condition of the Sudan, is entering the country, so that it may be fairly expected that in the course of the next five years the population will have attained some six millions, and thus doubled its present total.

When we conquered the Sudan there was hardly a single inhabitant who possessed any money, and, with the exception of the fighting men, the whole population was practically starving. In re-visiting the country nothing has struck Lord Kitchener more than the great increase in the individual prosperity of its inhabitants. It is not too much to say that there is now hardly a poor man in the Sudan. Unlike the Egyptian fellah, the Sudan cultivators are not bound down by debts to usurers, the benefits of peace have been fully reaped by the cultivators, and increased facilities of communication have brought to their doors markets hitherto undreamt of. It is, therefore, not surprising that the people are contented, loyal, and happy.

EMPIRE NOTES.

Empire Migration.—The question of Empire migration is becoming increasingly important, as the need of the Oversea Dominions for population is becoming more insistent. Canada and Australia during the past year have drawn largely from the British Isles, but are endeavouring this year to secure still larger numbers of British settlers. And now South Africa is beginning to realise the necessity of meeting the rapid growth of her coloured population, and their development in education and the arts of peace, by a corresponding increase in the number and strength of her white population. So that it would appear that South Africa may, and indeed must, ere long enter the lists as a competitor for the surplus people of the United Kingdom if she is to preserve her standing as a British possession. This fact has been recently accentuated by statistics which show that the natural increase of the coloured races in that country is far greater than that of the white race. Even in those districts which are purely Boer, the rate of increase in the white population is lower than that of the black, notwithstanding that the Boers, like the French-Canadians, are a prolific people. How far these various requirements, important and clamant as they are becoming, can be met by Great Britain and Ireland it is difficult to say, especially in view of the rapid depletion of some of our country districts, but that the necessity of dealing with the question on broad Imperial lines is urgent is undoubted. This fact is further brought into prominence by the report just issued by the Canadian Government, drawn up by Mr. Arthur Hawkes, who paid a visit to this country a few months ago as special Immigration Commissioner, charged with the duty of studying the conditions and possibilities of emigration from these isles to Canada. He calls for an increase of "the sum of immigration" and for the systematising of its methods so as "to secure the maximum efficiency and permanence of the incoming stream." To do this, he advocates the establishment in Canada of a Federal Board on which representatives of the Provincial Governments should sit, under the presidency of the Canadian Minister of the Interior. This may be, and probably is, a wise suggestion from the Canadian point of view, but there is surely a need for some action on the part of the Home Government, in order that the whole question of Empire migration should be so treated as to promote the interests of all the partners in the Imperial bond.

Vancouver to Yokohama.—The energy and ambition of the Canadian Pacific Railway have received a fresh illustration in the proposal so to extend their service to the Orient, by land and sea, as to make it possible to travel from Vancouver to Yokohama in eight days. The present liners to the Orient take, on an average, twelve days, but recently the "Empress of Japan" made the trip in a fraction over ten days, and the improved Trans-Pacific "Empresses," with their guaranteed speed of 18 knots as against the 13-knot boats at present in use, may reduce the time over the route now taken to nine days. Still faster boats, however, may be employed which, with the extension of the railway system from Esquimalt and the Nanaimo branch of the C.P.R. from McBride Junction northward towards Comox, will enable passengers to be conveyed to and from Vancouver and Yokohama in eight days. What with this proposal and their European Continental railway project, and the many schemes—ready-made farms and other land settlement devices—which the management has undertaken, the C.P.R. is setting the pace in a really marvellous manner for all the other great railways of the Dominion.

Canadian Municipal Taxation.—The adoption in Canada of business and income taxes, and the system employed in the assessment of municipal properties, in place of the old property tax, appear to great advantage in Toronto, where the present rate, 18 mills to the dollar—equal to $4\frac{1}{2}d.$ in the £

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—produces a revenue of a little over six million dollars (£1,200,000). The value of this assessment is considerably in excess of what it was in 1875. In that year the total assessment for taxation was 46,500,000 dollars (£9,300,000), which, at the rate then prevailing of 14 mills to the dollar, produced a revenue of 651,000 dollars (£130,200). In 1912, the total assessment has risen to 343,600,000 dollars (£70,000,000), yielding, as stated above, a revenue of £1,200,000. The 1912 assessment is distributed as follows:—real property (land and buildings), 291,600,000 dollars; business, 38,200,000 dollars; and income, 13,800,000 dollars. The total number of individual assessments is 127,000. The practice in valuing the different classes of property for assessment varies. Real property, in the residential districts, is taken at its full market value, but the business tax represents a fixed percentage of the real assessment, and varies with the class of business. Thus, a distillery would pay on 150 per cent. of the assessment value; a brewery, railway, or financial house, on 75 per cent.; a manufactory on 60 per cent.; professional, on 50 per cent.; retail merchant, on 25 to 30 per cent.; and a large departmental store, on 30 per cent. of the assessment value of land and buildings. The income tax is based on voluntary declaration, but an allowance is made of 1,200 dollars in the case of householders, and 600 dollars for single persons. The rate is struck annually, and is regarded as much more applicable to modern conditions than the old-time property tax.

Canada and the West Indies.—The important trade agreement between Canada and the West Indies, by which it is proposed to establish closer commercial relations between these countries, was signed at Ottawa on April 10th, in the presence of H.R.H. the Duke of Connaught. Before, however, it comes into operation, it will have to be submitted to, and approved by, the West Indian Legislature, and the Dominion Parliament. No opposition is anticipated, as the agreement has been received by the people, both in Canada and the West Indies, with the utmost satisfaction. To give practical effect, however, to the arrangement, one of the most important provisions is that of closer intercourse by improved cable and steamship communication, on which point the conference which adopted the agreement embodied their views in resolutions urging the necessity and importance of active co-operation in the matter between the West Indies, Canada, and the United Kingdom. These resolutions declare that improved cables are required, and that the most acceptable plan would be by extending the cable system from Bermuda to Barbados, Trinidad, and British Guiana, with the necessary provision for inter-island connections. It is recommended that the work should be carried out through the medium of some responsible cable company, which should be secured, for a term of years, against loss or insufficient revenue by a joint guarantee by the Imperial and Colonial authorities. In the same way, co-operation is to be sought for the providing of an efficient service of ships, so arranged as not only to meet the requirements of trade, but to make connection with the Canadian mail steamers, plying between Canadian and British ports. At present the Imperial Government provides £8,000 only for telegraphic communication, as compared with £16,000 in 1907, while for steamer service the grant, which was formerly £98,900, has been reduced to £52,500. It is hoped and believed that this effort to raise the prosperity of the West Indian Islands, with the assistance of Canada, will meet with appreciation on the part of the Imperial Government.

Australian Trade.—The Melbourne *Journal of Commerce* has published some interesting particulars of Australian trade for 1911. In noting that the increased export of Australian produce is satisfactory, it states that, in relation to the expansion in imports or purchases of goods, the position is not so sound as it should be. In view of the fact that there has been very little borrowing from abroad to inflate imports, it thinks that the purchases of merchandise have been excessive, and that the margin of exports has not, of late, sufficed to meet interest obligations, especially if the gold shipments include, as it is suspected they do, a considerable amount of money withdrawn for investment elsewhere. The total value of all imports for 1911 was £66,860,303, compared with £60,014,351 in 1910, an increase equal to 11·4 per cent. Included in this total was gold bullion and specie to the value of £1,991,064, which leaves the value of the net merchandise imported £64,869,239, or an increase equal to 10·55 per cent. on the previous year. These figures constitute a record, and show that the gross imports for 1911 were equal to £14 13*s.* 7*d.* per inhabitant. The gross value of exports to all oversea countries was £79,484,270, or £4,993,126 more than in 1910, which is equal to about six per cent. This amount includes oversea goods re-exported to New Zealand, the South Sea Islands, and other places, to the value of £3,260,393, leaving the net Australian produce at £76,223,677. The shipments of gold and specie included in the above returns were relatively heavy last year, amounting in value to £10,437,675. Deducting, therefore, this amount, the exports of merchandise showed a decrease for 1911 of £2,281,508, equal to 3·46 per cent., as compared with 1910. The value of the gross exports averaged £17 9*s.* per inhabitant. It is evident from these figures, whatever special deductions may be drawn from them, that the volume of Australian trade is increasing rapidly, and that both as a producer and a customer, the continued progress of Australia is assured.

The Western Australian Pearling Industry.—The decision of the Commonwealth Government that only white labour shall be used in

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connection with the pearling industry of Australia after this year, has already begun to bear fruit. The Pearlers' Association of Western Australia has recently imported from England a number of men to act as divers and tenders. According to the report of the Association, the men engaged appear to be steady and industrious, and give promise of being fully up to their work. The industry itself, despite vicissitudes in the shape of occasional cyclones, continues to be a most profitable one and its prosperity is increasing. In 1910 the total export of pearls and shell amounted in value to £348,911, the largest total recorded in the history of the trade. Complete figures are not yet available for 1911, but an approximate estimate given of the value of the shell exported is £240,764, apart from the value of the pearls, of which no estimate has yet been made. Broome is the chief centre of the pearling industry of Western Australia, but other localities on the north-west coast are extending their trade in this direction.

The Tropical Diseases Bureau.—The Colonial Office has recently issued an important paper respecting the establishment of the Tropical Diseases Bureau, which was first started in 1908 as the Sleeping Sickness Bureau, and which was housed in the premises of the Royal Society. Excellent work has been done by the latter in dealing with the question of sleeping sickness, but it soon became evident that what was done for that disease could be done for tropical diseases generally. It has therefore been determined to extend the scope of the bureau, and to locate it in the Imperial Institute. The new bureau will deal with all exotic diseases, which are prevalent in tropical and sub-tropical regions, and will publish, at frequent intervals, a tropical diseases bulletin. The director will have the help of an assistant director and a number of experts, who will be responsible for the different subjects, and will furnish authoritative reviews and summaries of published papers to appear in the bulletin. In this way the results of the most recent researches into every tropical disease in every country, and of the adoption of new methods of treatment and improved means of prevention, will quickly become available for the remote worker in the tropics. The tropical diseases of animals, which will also be treated, will be reported upon in a separate publication. The bulletins will be provided free to the medical and veterinary officers of India and of the subscribing Colonies. No more important work, in the interests of our Colonial possessions, could be undertaken than that of this bureau. To the Crown Colonies, and even to Australia, its work, supplemented as it will be by that of the various branches or independent bureaus engaged in similar investigations in the tropical and sub-tropical districts of these countries, will be of the greatest value, both for prolonging and saving life, and for the development of valuable tropical industries.

CORRESPONDENCE.

THE METRIC SYSTEM.

With reference to the notice of Colonel Nicholson's book, "Men and Measures," which appeared in the *Journal* of June 7th, the following letter has been received from M. C. E. Guillaume, Director of the International Bureau of Weights and Measures:—

Les adversaires du Système métrique possèdent tout un arsenal d'arguments qui côtoient d'assez près la vérité pour trouver créance et cependant s'en éloignent assez pour créer dans les esprits non prévenus, des notions fort erronées concernant la véritable situation du Système métrique dans le monde.

Tout d'abord, il est rare de trouver, dans les écrits de ces irréconciliables ennemis du système, une liste complète des États dans lesquels il est obligatoire ou légal. Cette liste est pourtant éloquente : la voici pour l'époque actuelle. Le Système métrique est obligatoire en Allemagne, Autriche, Argentine, Belgique, Brésil, Bulgarie, Chili, Colombie, Cuba, Danemark, France, Hollande, Hongrie, Italie, Luxembourg, Mexique, Montenegro, Norvège, Pérou, Portugal, Roumanie, Serbie, Suède, Suisse, Uruguay. La Grèce, le Siam, les Républiques de l'Amérique centrale ont décidé de l'adopter à bref délai à titre obligatoire ; enfin, il est légal en Bolivie, en Égypte, aux États-Unis, dans le Royaume-Uni, au Japon, au Paraguay, en Russie, en Turquie, au Venezuela. Nous aurons tout dit lorsque nous aurons ajouté que, dans plusieurs de ces pays, il est obligatoire pour certains usages, et que, dans la réforme toute récente de ses poids et mesures, la Chine a adopté une unité de longueur exactement égale à 32 centimètres, avec division décimale, montrant ainsi l'intention bien nette de préparer la réforme plus complète qui consacrera un jour l'adoption des unités métriques.

Je ne nie point que la réforme métrique, ainsi qu'y insiste M. Nicholson, n'ait été nulle part spontanée, et que partout il ait fallu une intervention des pouvoirs publics pour l'imposer, mais c'est là le fait de toute réforme à laquelle un grand nombre de personnes sont intéressées, et qui, si elle n'est pas simultanée, entraîne des confusions purement intolérables. Ici, aucune conviction, si profonde soit-elle, de la supériorité d'un système, ne peut remplacer l'action gouvernementale ; le terrain ayant été abondamment préparé par les œuvres scolaires ou par une propagande systématiquement organisée, il faut, pour franchir le dernier pas, qu'à un jour donné, les anciennes mesures soient interdites, pour faire place exclusivement aux nouvelles ; mais la constation de ce fait ne diminue en rien la valeur d'un système devenu déjà presque universel.

Deux autres arguments, qui ont déjà servi, mais ne semblent point encore usés, sont, entre eux, absolument contradictoires. Aux uns on déclare,

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le Système métrique est un tyran très dur, auquel il faut soumettre immédiatement toute quantité susceptible de mesure, qu'elle soit commerciale ou industrielle, et, pour cette raison, l'introduction du Système dans le Royaume-Uni coûterait aux seuls filateurs, la somme prodigieuse de cent millions de livres (Mr. R. H. Barran à la Chambre des Communes, 22 mars 1907).

Aux autres, on affirme, le Système métrique réussit si peu à s'imposer, qu'en France même, où il fut créé il y a plus d'un siècle, il n'est pour ainsi dire pas employé.

Ces deux arguments ne sauraient être simultanément acceptés que si la passion enlève au jugement son libre exercice; il faudrait savoir choisir entre eux. Mais le fait qu'ils sont exclusifs l'un de l'autre ne les empêche nullement d'être tous deux erronés, comme le démontre surabondamment l'examen des faits.

Le premier part de cette idée, que l'adoption du Système métrique obligerait à régler toute la fabrication industrielle sur des valeurs métriques simples. Mais, où a-t-on vu que la réforme eût de telles exigences? D'abord elle peut, pendant une période transitoire, laisser toute liberté à l'industrie, et ne s'applique qu'au commerce, ensuite, lorsque, dans la deuxième période, elle comprendra la production industrielle, elle n'aura pas d'autre signification que celle-ci: les dimensions des machines ou des objets fabriqués seront exprimées en unités métriques. Là, par exemple, où l'on avait dit 3½ inches, on dira 88. 9 mm., et chacun se comprendra comme auparavant. Sans doute, pendant un temps, les nombres les plus fréquents seront plus compliqués qu'autrefois, mais peu à peu les nouvelles machines seront construites sur des données numériques simples, et là où les dimensions avaient été fixées à 3½ inches, on les arrêtera à 90 mm. ou 9 cm. On n'aura brisé aucune vieille machine, on aura seulement modifié légèrement quelques dimensions dans les machines de construction nouvelle.

Dans bien des cas même, les anciennes dimensions pourront être conservées sans inconvénients. Sait-on, par exemple, quel est le calibre des grosses pièces de marine dans les pays continentaux? 305 mm., c'est à dire assez exactement 12 inches, et maintenant on construit des pièces de 356 millimètres, ou 14 inches. Les dimensions primitivement adoptées par l'Amirauté britannique ont été conservées dans les pays métriques, elles sont exprimées en millimètres au lieu de l'être en inches, voilà toute la différence. Si l'on avait commencé cette construction en France ou en Allemagne, on aurait pris vraisemblablement 300 ou 350, peut-être 260 millimètres, les nombres eussent été plus simples: là serait, au point de vue métrologique toute la différence.

Le second argument n'est pas de meilleure tenue. Il est parfaitement exact qu'en Allemagne, et même en France, la vente au détail se fasse beaucoup au Pfund ou à la livre. Mais qu'est-ce à dire? Livre ou Pfund est le nom abrégé de 500 grammes ou ½-kilogramme. La mesure est légale, sinon le nom, et la vente à la livre est faite conformément aux unités du Système métrique. Je n'irai pas jusqu'à dire que l'on doive chercher à conserver ces vieux mots qui ne sont pas inscrits dans la loi; mais l'infraction au système n'est qu'en surface, et ne touche nullement le fond des choses. Si le système n'est pas complètement appliqué dans la lettre, il l'est du moins dans son esprit. L'habitude populaire est vivace, il faut lui faire quelques concessions.

En Allemagne, au point de vue légal, la question se présente sous un jour particulier. La loi impose les unités, mais est muette sur la nécessité de la nomenclature; en disant Pfund, on n'enfreint pas la loi; la pesée est faite avec des poids métriques vérifiés, c'est tout ce que la loi exige, et il faut juger bien superficiellement les choses pour pouvoir dire que le Système métrique n'est point appliqué.

A ce propos, les étrangers ne distinguent pas toujours assez le langage correct de l'argot (slang); les mots bizarres sont les premiers qui frappent.

Dans les quartiers excentriques des grandes villes, les pièces de cinq centimes, d'un, cinq et dix francs portent couramment les noms de *rond*, *linvé*, *thune* et *sigue*, et les billets, celui de *fafiots*, tout comme, dans les campagnes, la pièce de cinq francs est un *écu*, et celle de dix francs une *pistole*; et, si M. Nicholson avait fréquenté les cercles où l'on joue, il saurait que vingt francs se dit invariablement un *louis*, et qu'à Monte Carlo, la pièce de cent francs se nomme une *plaque*.

Ce sont là des fantaisies qu'il faut savoir tolérer; elles ne constituent pas plus des infractions graves au Système métrique ou monétaire que les mots *melon* ou *tube*, ou même *galurin* ne constituent des infractions graves aux principes de la chapellerie; ou, à Londres, les mots "tube" et "bus" une atteinte aux réglements sur les transports.

Tout en désirant la parfaite correction du langage, ne peut-on faire un sacrifice à ces habitudes chères au peuple? Et n'est-ce point en insistant outre mesure sur ces incorrections que l'on mériterait le reproche emprunté à Napoléon, et que rappelle M. Nicholson: "It is tormenting the people for trifles!" Au moment de la réforme métrique, on a peut-être un peu tourmenté le peuple; mais c'était alors pour une chose fort sérieuse; une énorme économie par la simplification à l'extrême dans tout ce qui est susceptible de mesure; c'est maintenant que les "trifles" pourraient commencer. Le temps sera ici le plus sûr réformateur; le fond est obtenu; tout en insistant sur la forme, sachons y appliquer un peu de patience.

CH. ED. GUILLAUME.

OBITUARY.

ROBERT VIGERS.—The Society has lost one of its oldest members by the death of Mr. Robert Vigers, which took place on the 22nd inst., in his eighty-

sixth year. Mr. Vigers joined the Society as long ago as 1858, and in 1909 the Council elected him an honorary member.

Mr. Vigers, who only retired from practice some four years ago, was well known in the City as a land agent and surveyor. In addition to their large private business, his firm was frequently consulted with regard to the compulsory acquisition of land for public purposes. He acted in connection with the purchase of land required by the London, Chatham and Dover Railway from Beckenham into London; he was retained in the matter of the purchase of the telegraphs by the State, the acquisition of tramways by local authorities in all parts of the kingdom, and in the extension of the Great Central Railway to London. He was also arbitrator in many of the Manchester Ship Canal claims, and he was engaged in innumerable assessment appeals.

Mr. Vigers was President of the Surveyors' Institution in 1898, and originated the benevolent fund of that body. He served on the committee of the Estate Exchange, and was a member of the Land Surveyors' Club and of the Surveyors' Association.

GENERAL NOTES.

Mineral Production of Canada, 1910.—The total value of the mineral production in Canada in 1910, according to the annual report of the Canadian Department of Mines, was $106,823,623. This figure, compared with the total for 1909, shows an increase of 16 per cent., and is the largest increase that has been recorded in any one year. Coal occupied the first place, contributing about 29 per cent. of the total; silver came second, with over 16 per cent.; nickel came third, with over 10 per cent.; gold fourth, with 9½ per cent.; clay products contributed 7 per cent.; copper, 6·6 per cent.; and cement, 6 per cent. The increased production was distributed well throughout the list of ores and minerals. Amongst the metallic products the principal increases were in silver, nickel, gold and copper, there being a falling-off in the production of lead and zinc. There was an increase of pig-iron from blast-furnaces, but a decrease from Canadian ore.

Iron and Steel Institute. — The autumn meeting of the Iron and Steel Institute will be held at Leeds from September 30th to October 4th, 1912. An influential reception committee has been formed with Lord Airedale as chairman. A number of papers will be read and discussed, and visits will be paid to works and places of interest in the neighbourhood.

Importation of Vines to Russia.—During the last few years considerable quantities of vines have been imported to the South of Russia. A recent report of the French Consul at Odessa states the number of rooted plants as well as grafts and cuttings of the vine, which in 1908 amounted to 2 million plants and 100,000 grafts, had increased to 4 millions and 1,300,000 respectively in 1911. In 1909, however, the number fell to 800,000 plants and about ¾ million grafts and cuttings, whilst during the following year 2½ millions of the former and 1,380,000 of the latter were imported. The districts of the Caucasus are not included in these figures.

Japanese Tea Production.—The cultivation of the tea plant, which is a shrub with an average life of fifteen years, is general throughout Japan; the area devoted to it aggregates 123,062 acres. The Prefectures of Shidzuoka, Saitama and Miye, are the principal suppliers to the export trade, while Kyoto, Nara and Gifu largely supply the home market. Kumamoto, Fukuoka, and Kochi Prefectures produce black teas. At the time of picking the leaves are fired once, and then sent to the factories, which are usually located near the export markets. Here the tea is refired and cured, and prepared for shipment and consumption. The export centres of Japan are not numerous, there being only six of importance—Yokohama, Kobe, Moji, Shimidzu (the port of Shidzuoka), Yokkaichi (for Miye exports), and Nagasaki. Tea is grown in every prefecture of the main archipelago, except the most northern one, Aomori. The quantity of tea shipped from Japan in 1911, amounted to 43 million pounds. The United States is the largest importer of Japanese tea.

Bee-farming in New Zealand. — The production of honey in New Zealand during the last few years has shown a rapid increase, and so much interest is now being evinced in bee-farming that it seems likely the industry will attain considerable proportions. There are approximately 16,000 keepers of bees scattered over New Zealand. The total exports of honey for the last two fiscal years were: 1909–10, 28,000 lbs., valued at £920; 1910–11, 116,000 lbs., valued at £2,350. The industry has received great assistance from the passage of an Act, some years ago, requiring Government inspection of all the apiaries in the country, forbidding the use of box hives, and compelling the destruction of all disused colonies of bees. There are four Government inspectors at present. Up to the time of such Government regulation, the disease of foul brood was so prevalent throughout New Zealand as to render impossible any successful development of the bee-farming industry, notwithstanding the great advantage of climate and the large areas of land sown in clover. To encourage the industry, the New Zealand Government has established model apiaries at Ruakura and Waerenga, in charge of expert beekeepers, whose duties include the instruction of students of bee culture. Very interesting demonstrations are given at these model apiaries, including preparation of by-products, such as mead and honey vinegar, from odd scraps of honey and broken honeycombs.

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Journal of the Royal Society of Arts.

No. 3,111. VOL. LX.

FRIDAY, JULY 5, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday afternoon, the 3rd inst. Present:—Sir William Lee-Warner, G.C.S.I. (Chairman of the Committee), Sir Arundel T. Arundel, K.C.S.I., Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D., Sir Valentine Chirol, Sir Steyning William Edgerley, K.C.V.O., C.I.E., Sir Krishna Govinda Gupta, K.C.S.I., Sir James John Digges La Touche, K.C.S.I., R. A. Leslie Moore, I.C.S. (Ret.), Carmichae Thomas, Sir James Thomson, K.C.S.I., M.A., with Sir Henry Trueman Wood (Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Section).

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE MEAT INDUSTRY.*

By Loudon M. Douglas, F.R.S.E.,
Technical Adviser on Animal Industries.

Lecture I.—Delivered February 5th, 1912.

The Bullock and its Products.

In addressing this representative gathering on the subject of the meat industry, I should like, first of all, to invite attention to some general considerations which affect the whole subject.

The meat industry is one of the oldest known to mankind, and the handling of meat in various forms has been practised since long before historic times; but there have been many changes in the art of handling meat and meat products throughout the different ages, and the student of the subject cannot but be struck with the fact that in earlier times there was no such thing as organisation in the meat industry, and very little recognition. There never has been any attempt to supply systematic education to the meat industry in the same way as has been provided for other branches of the food supply, such as dairying, notwithstanding the fact that the ramifications of the meat industry are far beyond those of any other food products. As we proceed, it will become evident what this absence of organised technical education in the meat industry means to this country, and we will endeavour to compute what would be the gain if matters were arranged otherwise.

In the meantime it may be well to remember that much progress has been made in the organisation of meat purveyors during the last quarter of a century. During that time the National Federation of Meat Traders' Associations of the United Kingdom has come into existence, and has united the common interests of the industry all over the country by means of some 150 different local associations with a membership of over 20,000. Such an organisation has immense power in its hands, and it remains to be seen whether its future policy will be an enlightened one with regard to this question of technical education as well as to other subjects, to which we will refer in their proper place.

The Extent of the Meat Industry.

Few people realise the fact that the meat industry is one of the largest in the world. It is really a higher development of agriculture, inasmuch as the meat handler takes charge of the live-stock of the farm when the farmer is finished with it. Some idea of the vastness of the subject may be gathered from the statement that in Europe alone we have over 121,000,000 cattle.* In North America there are approximately, 80,000,000; in South America about

* The illustrations are reproduced from "The Meat Industry and Meat Inspection" (5 vols.), by G. L. Leighton, M.D., and Loudon M. Douglas, F.R.S.E., by permission of the publishers, The Educational Book Co., Ltd.

* "Statistique des Superficies Cultivées, de la Production Végétale et du Bétail," Institut International D'Agriculture, Rome, 1910.

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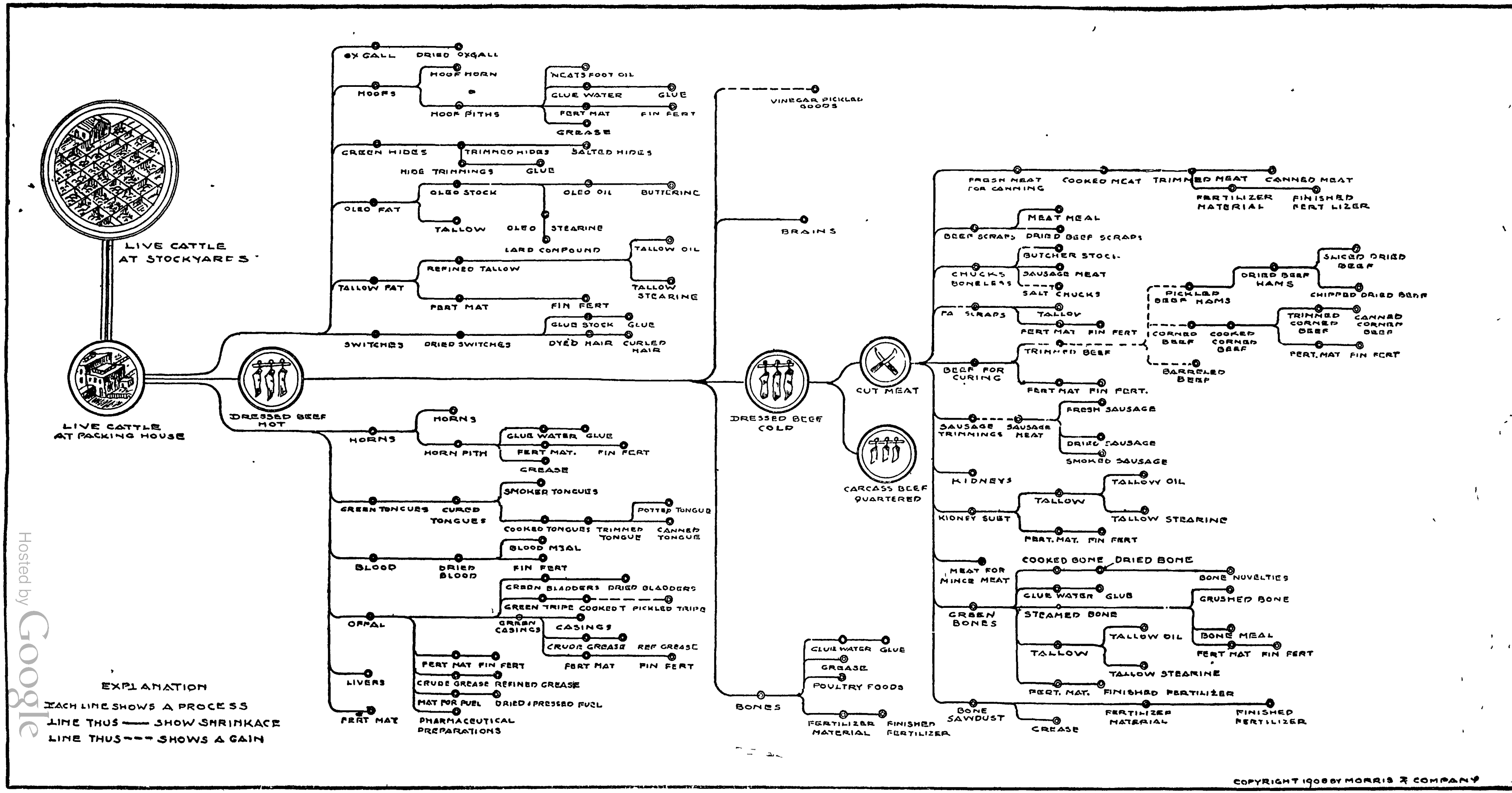

FIG. 1.—DIAGRAM SHOWING THE VARIOUS PRODUCTS DERIVABLE FROM A BULLOCK.

43,000,000; in Asia, 97,000,000; Australia, 12,000,000; Africa, 1,250,000, and these areas may be looked upon as the principal cattle-producing countries in the world, the total supply in all of them being computed at 255,451,985. These are colossal figures, which are really beyond the ordinary comprehension, but they serve to emphasise the fact that while there is such an enormous supply of cattle throughout the world, we in this country are the largest buyers of meat products per head of our population; and it is a remarkable thing that while the meat products from overseas continue to come to this country in increasing quantities from year to year, our own cattle population remains pretty stationary at about $11\frac{3}{4}$ millions,* of which it is computed that we slaughter about 25 per cent., or something under three millions per annum. But the cattle so handled in this country are utilised almost exclusively from the point of view of the meat purveyor, and not from the point of view of the packing-house. That latter idea has yet to be developed in this country, and there are not wanting signs that many people are of opinion that it is a feasible proposition. In the United States there are 936 packing-houses,† and a great many of these came into existence and have developed largely through being able to ship their products to Europe and principally to British markets. Of cattle alone they handle something like 8,000,000 per annum, and while that is a large number, and is constantly on the increase, the exports are becoming smaller and smaller, owing to the increase of the population of the United States and the local demands. These fluctuations in the sources of supply of foreign meat have led to many curious results, which, in so far as the United Kingdom is concerned, have meant that while the meat supplies from North America have dwindled, they have increased enormously from South America. It would seem, however, that if the United States cannot supply large quantities of meat products to the United Kingdom, the packers of that federation are determined still to make a bid for British trade, and one of the recent steps which a number of American packers have taken, has been the purchase of 9,000,000 acres of land in Brazil* for the purpose of ranching cattle and other live-stock, so as to supply the increasing demands in Europe and the British markets.

* The total number of cattle in Great Britain, according to the agricultural returns for 1911, was 7,114,264, and according to the agricultural statistics of Ireland for the same year the number in that country was 4,688,888.

† *The National Provisioner*, January 20th, 1912. Report of Mr. Secretary Wilson's address at the Annual Convention of American Packers.

Imports of Foreign Meats.

We have seen that the home supply of beef is a comparatively steady one, but we are bound to take note of the fact that the imports are steadily on the increase, and amounted in 1911 to a total of fresh and refrigerated meats of 7,362,434 cwts., being the largest quantity on record. The value was £11,136,223, but this was considerably less than the previous year, for causes which we need not examine here. The main feature to note is that the supplies brought are steadily on the increase,† and came from overseas countries where the handling of meat products has been most highly developed, and where the greatest possible care is taken to utilise all the residual products.

* *Cincinnati Price Current*, January 4th, 1912.

† "Accounts Relating to Trade and Navigation of the United Kingdom," December, 1911.

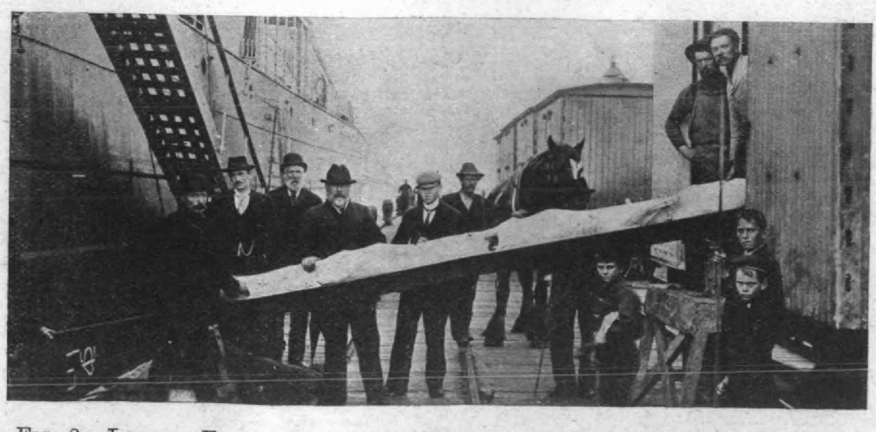

Fig. 2.—Loading Frozen Carcasses of Mutton from New Zealand to England.

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Imports of Foreign Beef into the United Kingdom.

Meat.	Quantities.			Values.		
	1909.	1910.	1911.	1909.	1910.	1911.
	cwts.	cwts.	cwts.	£	£	£
Beef, fresh and refrigerated:—						
Fresh: From Denmark . . .	54,773	42,293	4,125	131,926	107,750	11,188
Fresh: ,, other countries .	7,551	14,641	5,210	18,079	33,400	11,456
Total	62,324	56,934	9,335	150,005	141,150	22,644
Chilled: From U.S.A.	830,689	469,444	169,444	1,900,858	1,056,722	387,296
Chilled: ,, Uruguay . . .	—	—	—	—	—	—
Chilled: ,, Argentine Republic	1,826,612	2,710,747	3,753,140	3,351,245	4,950,326	5,902,818
Chilled: ,, Australia . . .	2,180	2,226	2,240	3,965	3,402	3,670
Chilled: ,, New Zealand . .	—	—	129	—	—	242
Chilled: ,, other countries .	4,092	9,348	8,084	10,259	12,348	10,456
Total	2,663,573	3,191,765	3,933,037	5,266,327	6,022,798	6,304,482
Frozen: From U.S.A.	25,527	7,703	4,906	48,478	13,577	10,305
Frozen: ,, Uruguay . . .	127,924	142,269	65,485	175,149	202,645	88,543
Frozen: ,, Argentine Republic	2,381,543	2,188,122	2,357,878	3,382,328	3,306,658	3,339,263
Frozen: ,, Australia . . .	409,397	878,469	708,388	586,371	1,236,091	964,050
Frozen: ,, New Zealand . .	454,368	532,830	257,806	660,319	797,535	374,023
Frozen: ,, other countries .	15,866	17,406	25,608	24,429	24,692	32,908
Total	3,414,625	3,766,799	3,420,071	4,877,074	5,581,198	4,809,097
Total of beef, fresh and refrigerated				10,293,406	11,745,146	11,136,223

The Meat Industry in the United Kingdom.

The Breeding of Beef Cattle. — This brings us to the question of the conduct of the meat industry in the United Kingdom. As has been indicated, the methods of handling cattle for food in the United Kingdom do not at present partake of that kind of specialisation which exists in other countries. We have undoubtedly specialised the breeding of cattle more than any other nation, and our leading beef breeds—the Aberdeen-Angus, the Herefords, the Devons, the Galloways—are known in many parts of the world, as are also our dual-purpose breeds, the Shorthorns, Lincoln Reds, and Red Polls. The meat purveyor, however, has only an academic interest in the breeding of cattle and the specialisation of breeds; what he wants is an animal that will, when dressed, give him a minimum of bone to flesh, and a high percentage of carcass to live weight. Curiously enough, however, this aspect of the matter has only been recognised by breeders since 1895, previous to which date there was no recognition of the meat purveyor at our fat stock shows. As a consequence, what are known as "breeders' points" came into vogue, and, translated into actual practice, meant excessive fat of comparatively low value. It was in 1895 that the Smithfield Club of London, which holds the most notable fat stock show in the United Kingdom every year, provided a class for what is now known as the "block test," which means that

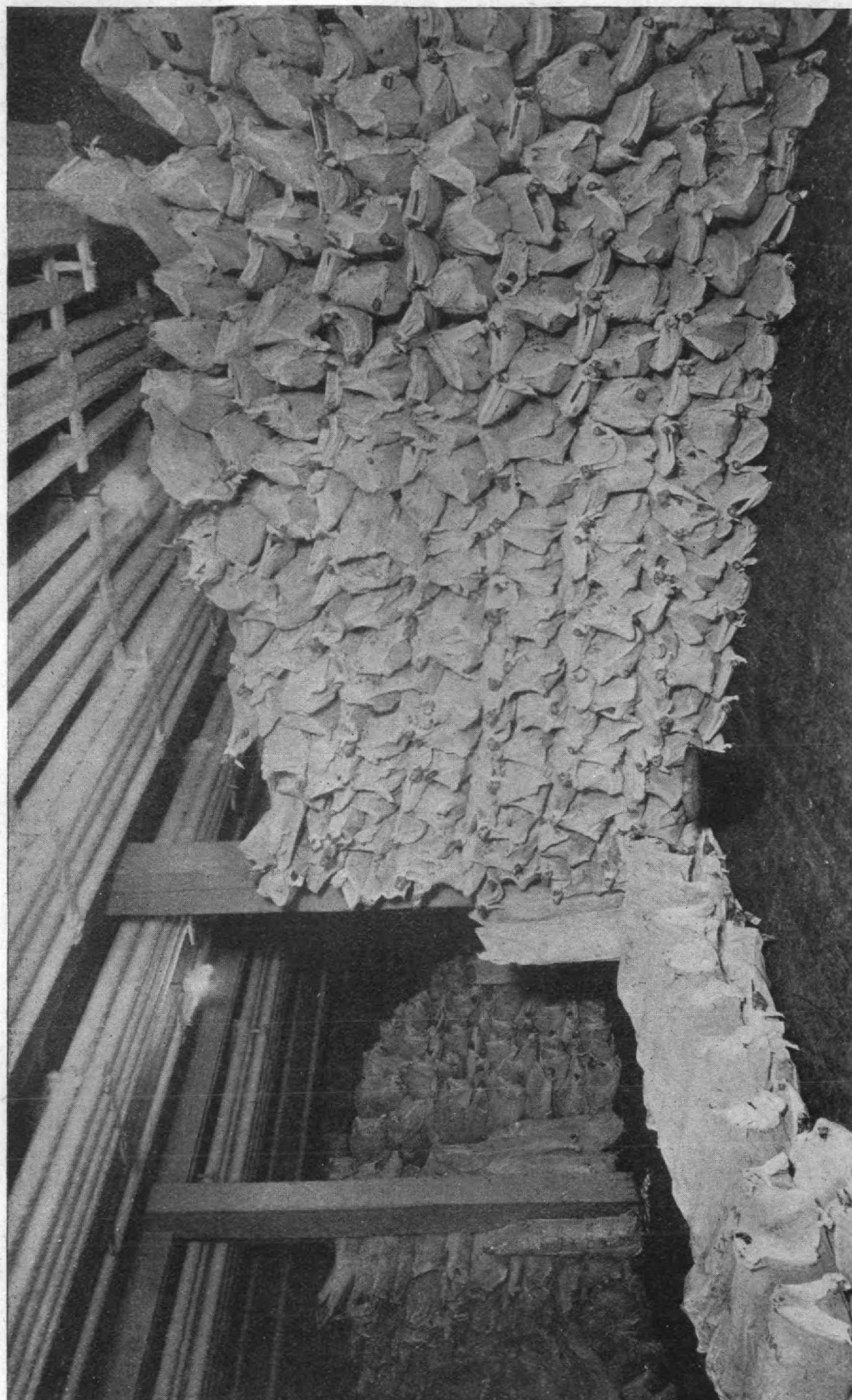

FIG. 3.—FROZEN MEAT IN COLD STORE BELONGING TO THE GOVERNMENT'S PRODUCE DEPARTMENT, ADELAIDE, SOUTH AUSTRALIA.

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animals have first of all to be judged alive, and subsequently judged in the carcass. Since 1895 this feature has been introduced at many fat stock shows, with the consequence that it has been of such high educational value that the breeders' standards are gradually being compelled to conform to the standards required by the carcass. This is very well illustrated by the fact that, so far, it has been found impossible to make the awards given to cattle at the Smithfield Show agree with the awards of the carcass meat, which is a demonstration of the absence of proper values corresponding in figures to various points of excellence. The figures for

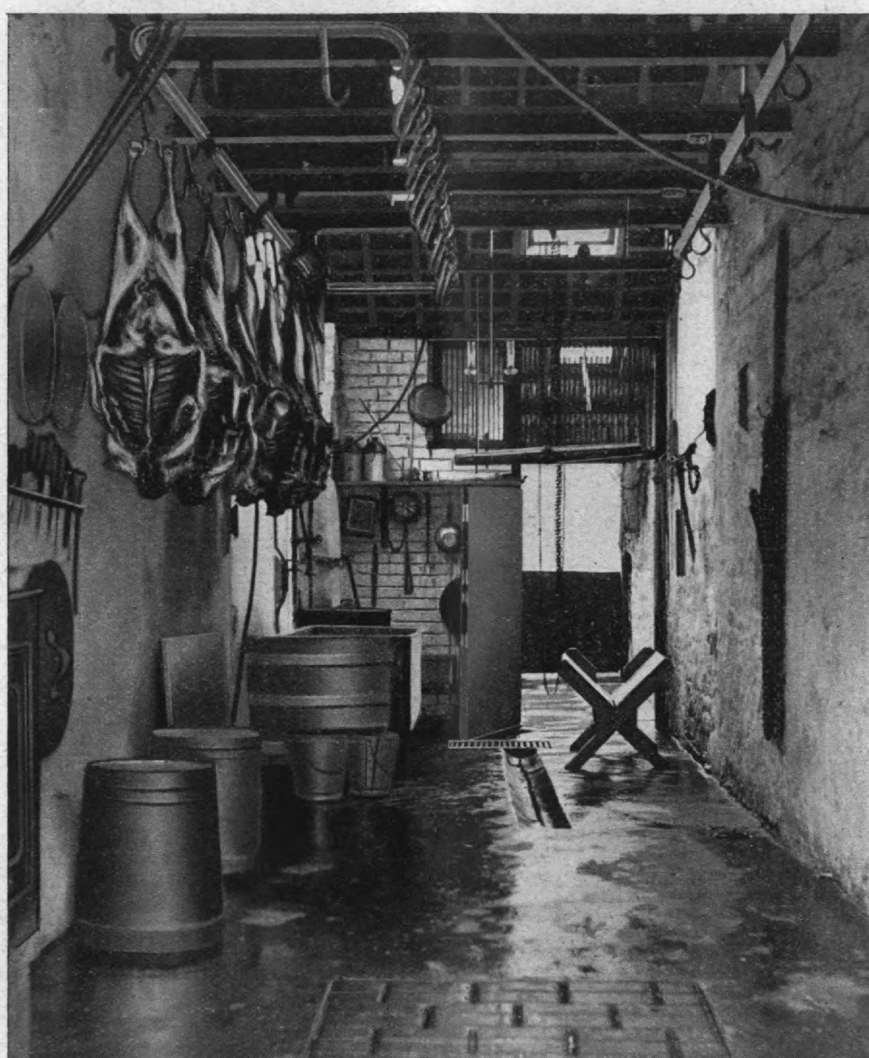

FIG. 4.—SMALL PRIVATE ABATTOIR, SHOWING AN ORDINARY WELSH MEAT-PURVEYOR'S EQUIPMENT.

This illustration provides an up-to-date example of a country meat-purveyor's establishment.

the meat purveyor. This transition in meat production is, however, far from being complete, and there is something wanted still in the judging of animals, so as to make the points of the live animal correspond to the points of the 1911 Smithfield Show exhibit a very good illustration of this.

One of the notable features in these carcass competitions would seem to be the determination of the dressing-out weight, which, in the best

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Awards in the Special Slaughter Class for Carcass Competition, Smithfield Club Show, 1911.

Steer not Exceeding Two Years Old.

No.	Live Weight. cwts.	qrs.	lbs.	Carcass Weight. stones (8 lbs.)	lbs.	Suet, Caul, Reed Fat. lbs.	Fat, Gut Fat, Trimmings. lbs.	Tongue, Tail. lbs.	Head, Feet. lbs.	Heart, Liver, Lights. lbs.	Tripe, Feck, Reed. lbs.	Hide. lbs.	Intestines. lbs.	Placed by Judges alive.	Carcass Award.	No.
593	12	1	11	115	6	18	34	13	55	38	86	93	16			593
594	10	1	14	93	5	16	21	11	48	34	86	84	17	3rd		594
595	14	3	8	140	6	16	25	13	61	38	132	112	16			595
596	13	2	18	126	5	25	40	12	61	34	100	108	20	R.		596
597	10	3	15	99	5	18	31	11	51	35	95	79	16		3rd	597
598	10	2	14	95	0	16	20	11	51	35	97	78	12			598
599	10	2	2	91	1	16	33	12	49	30	113	85	18			599
600	10	1	12	96	1	13	23	9	50	30	91	76	12		1st	600
601	9	3	23	91	4	17	33	10	44	29	89	71	13	2nd	4th	601
602	11	1	18	101	7	19	24	10	50	34	123	80	15		R. N.	602
603	8	1	16	71	4	20	17	9	39	25	106	69	11			603
605	11	2	22	106	0	12	32	11	44	40	116	76	18	1st	2nd	605

Steer above Two and not Exceeding Three Years Old.

No.	cwts.	qrs.	lbs.	stones	lbs.	Suet, Caul, Reed Fat.	Fat, Gut Fat, Trimmings.	Tongue, Tail.	Head, Feet.	Heart, Liver, Lights.	Tripe, Feck, Reed.	Hide.	Intestines.	Placed by Judges alive.	Carcass Award.	No.
606	14	2	19	140	7	25	45	11	52	39	105	83	23			606
607	13	3	13	123	0	22	33	12	29	43	157	105	17		3rd	607
608	12	1	6	111	0	26	39	13	52	43	107	84	19	1st	R. N. & C.	608
609	15	3	2	145	1	25	43	15	64	51	104	133	26	2nd		609
610	12	1	6	112	2	21	34	10	53	39	116	80	18	3rd	4th	610
611	10	1	18	94	3	14	19	13	48	30	113	81	12		1st & Champion	611
612	12	0	22	106	2	25	47	10	56	34	119	83	24	R.	2nd	612

Heifer not Exceeding Three Years Old.

No.	cwts.	qrs.	lbs.	stones	lbs.	Suet, Caul, Reed Fat.	Fat, Gut Fat, Trimmings.	Tongue, Tail.	Head, Feet.	Heart, Liver, Lights.	Tripe, Feck, Reed.	Hide.	Intestines.	Placed by Judges alive.	Carcass Award.	No.
614	11	1	22	105	2	24	38	11	46	31	88	71	24		4th	614
615	8	1	9	72	3	12	16	8	39	25	105	62	13			615
616	11	2	6	102	0	24	35	12	52	35	122	76	25	1st	1st & R. Champion	616
617	10	2	20	93	5	16	24	10	45	37	122	65	19	2nd	3rd	617
618	11	3	15	110	3	26	34	9	43	34	93	74	18			618
619	12	2	7	118	2	26	43	11	46	30	94	81	24	R.	R. N.	619
620	9	3	24	87	5	18	29	11	43	32	104	68	14	3rd	2nd	620

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class of animals, seems to reckon out at between 60 and 65 per cent.

The products from cattle at these carcass competitions are such as are generally recognised throughout the United Kingdom, and consist of:—

1. The carcass.
2. Suet, caul, reed fat.
3. Fat, gut fat, trimmings.
4. Tongue, tail.
5. Head, feet.
6. Heart, liver, lights.
7. Tripe, feck, reed.
8. Hide.
9. Intestines.

and form the basis upon which the meat industry is conducted.

The Slaughtering of a Bullock.—It will be opportune to mention here briefly the methods of slaughter which are adopted in the United Kingdom. The bullock is stunned with either a pole-axe, pistol, or humane slaughtering apparatus, a perforation being made in the middle of the roof of the cranium, which causes immediate unconsciousness due to concussion. The Jewish method, in which stunning is not adopted, is conducted by severing the arteries and blood-vessels of the neck, and it is also permitted in this country. The first process in the ordinary method of slaughtering* is that of bleeding, which, in the case where animals are previously stunned, is thoracic. The gullet is first of all opened, and the main vessels of the neck (carotid and jugular) are severed.

When the blood has flowed out, the animal is turned on its back, and is supported in this position either with blocks of wood or pritches. The feet are then cut off and the head severed; an incision is made in the hide, right down the forearms to the crown of the chest, and this is continued along the middle line from the chest to the base of the tail. Diagonal lines are then made down the hind legs, and flaying is started. The hide is first of all removed from the breast on the left side, and then on the right, and in order to facilitate operations later on, the breast is then sawn through and the "gips," "izening" bone, or pelvis, is also severed.

Fig. 5.—The Abattoir of the Co-operative Society at Stockton.

A gambrel is inserted under the sinews of the hind houghs, and the carcass is raised by means of a crane or self-sustaining hoist, and is suspended in the half raised position, so as to allow of the hindquarters being "buffed" or flayed. The hide is pulled down, and the tail is liberated. At this point the whole carcass is raised up, so that only the shoulders rest on the floor, and an incision is made near the centre middle line, and the thick fat or "crook" lining the abdomen is at once taken out. The paunch or stomach is then withdrawn, and the intestines, including the liver, are removed. The bed fat, however, lining the

* "The Meat Industry and Meat Inspection," by Gerald Leighton, M.D., and Loudon M. Douglas, F.R.S.E., Vol. II. p. 687.

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pelvis, and also the kidney fat, should be left undisturbed.

The intestines, being attached to the liver, can be cut free, and as the paunch is attached to the back, at the left side, it can be removed by merely pressing it downwards. The paunch, together with other intestinal offal, is thrown aside, so that it may be dealt with by others than those who handle the carcass.

The gall-bladder is then taken out, and the diaphragm, lungs, and heart are removed, after which the carcass is raised to the vertical position, and, in accordance with local custom, split down the backbone or vertebral column. In Scotland it is customary to split the carcass of a bullock from the front by means of a cleaver. In other parts of the country this same process is carried out from the back, and in some cases the splitting is performed with a heavy cleaver or a saw. In the city of Edinburgh—which may be taken as a typical example of what occurs in Scotland—the carcass is kept entire, after being split down the backbone—that is to say, the two sides are not severed entirely, but are kept united by means of a portion of skin.

FIG. 6.

VIEW OF A CATTLE-SLAUGHTERING BOOTH AT GLASGOW, AND SHOWS THE OLD-FASHIONED WAY OF KILLING ANIMALS.

When the carcass has been elevated to the vertical position, the hide, which at that moment should cover the shoulders only, is finally removed from the forequarters. The kidney fat should then be turned over, and the kidneys removed, the turning over of the fat being meant to give a good dressed appearance. When these operations have been completed, the whole carcass is washed out with warm water, and is wiped free from any blood or other matter which may be adhering to it.

The carcass is then in a finished state, and is at once placed in a position where it will cool, or where the animal heat may be allowed to dissipate. This may either be the hanging hall of an abattoir, or in the open space of a private slaughtering booth, but in any case this pre-cooling should only be allowed to continue until the excess of animal heat has disappeared.

The carcass may then be placed in a chill-room, where available, and chilled to a temperature of 40° F., when, after about twelve hours, it will be in a firm condition, and be capable of being handled for all purposes in connection with the meat trade.

The Carcass.—The handling of the carcass in the United Kingdom is carried on in both public and private abattoirs, and much discussion has taken place during recent years as to the advisability of centralising the whole business of slaughtering and handling of meat products in public abattoirs, the argument being that the ante-mortem and post-mortem examinations can be better carried out in public institutions than in the private establishment. The question of examination, however, with a view to the detection of disease, is only one of the many involved. As our knowledge progresses, we are led to the conclusion that sanitary surroundings are also necessary to the proper conduct of the meat industry, and such conditions do exist in all public abattoirs and many private ones; but I doubt if anyone will argue that the majority of private abattoirs are above suspicion. No doubt a good understanding will yet be arrived at in this matter, and there is no reason why the possessors of private abattoirs should not be recognised as possessing valuable vested interests, which should be met by compensation in the event of the general adoption of public abattoirs

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throughout the country. Apart, however, from the general question, it must be noted that there is also an economic one which is not generally appreciated—namely, that the profit of handling a bullock in a private abattoir is not nearly so great as in a public institution, and actual figures carefully obtained show the comparison to be much in favour of the public abattoir.

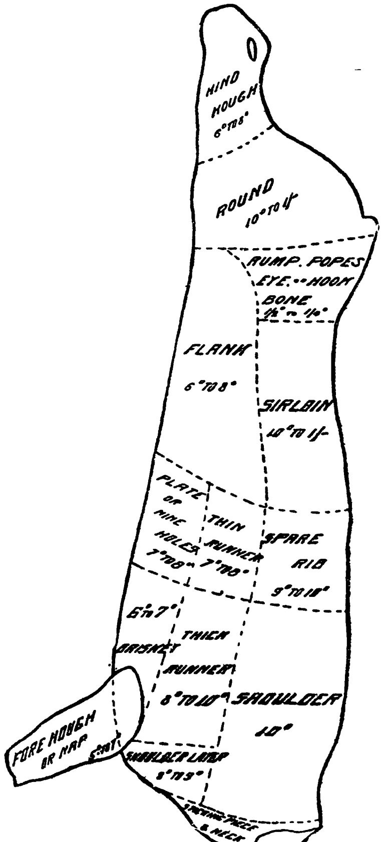

FIG. 7.—DIAGRAM OF A SIDE OF BEEF.
Showing average prices realised throughout the United Kingdom for various cuts.

The Chemistry of the Subject.—Generally speaking, the products of a bullock are two in number, namely, the carcass and the offal, a large portion of the latter being of an edible character. The carcass is built up on a framework of bones supported by tendons, muscles, and ligaments, through and in which the organs of circulation, respiration, digestion, excretion, and reproduction are enclosed, and the whole body is subject to a complex system of brain and nerves, which may be regarded as the motive power of the animal; but although all these various parts exhibit infinite detail, they may be reduced to three principal ingredients, namely, water, ash, and protein or nitrogenous substances, and the specialisation of this fact is what has led to the great development of the meat industry in different overseas countries. The carcass of the bullock is, in fact, looked upon as a source not only of food, but of the raw materials used in many of the arts and sciences. Curiously enough, there is a large quantity of water present in the bullock, which in a half fat animal may be put down at 50 per cent., decreasing to about 43 per cent. in a fat animal. Some parts of the meat, however, such as the round, show as much as 75 per cent. of water. The chemistry of the subject is, indeed, most interesting, and it is curious to note that while the composition of the carcass can be reduced to the three constituents, water, ash, and protein, the same classification may be applied to the plants upon which the animals feed. We have in them also what are known as carbohydrates, which consist of starch, sugar, etc., and which are found in the framework of the plants or stored up in the cells, and the whole science of feeding consists in so balancing the rations as to obtain the quick growth of the flesh at the minimum cost of food. Before this science of feeding was understood, bullocks were not supposed to attain maturity for a good many years. Now, however, the age of the highest grade beef animals at maturity is from twenty-four to thirty months, and the application of scientific methods in this direction has altered entirely our view of what meat ought to be. At the present day we demand that good beef should be of a bright uniform red colour, nicely marbled with fat, and should be firm and elastic, with the appearance of healthy meat juices.

The Cutting Up of the Carcass.—The cutting up of the carcass is carried out differently in various parts of the country, and the names applied differ also. The main principles are the same, and the ruling prices for the different sections work out pretty much to the same value for the whole carcass.

As has been pointed out, the dressing-out weight in the highest class of animals varies between 60 and 65 per cent., and the remainder of the animal consists of blood, fat, hide, and internal organs, and it is from these by-products that many articles of commerce are derived. The number of commodities which may be produced from a bullock is something like 146. A mere list alone, with the briefest possible description, would occupy a considerable length of time in writing. It will only be possible, therefore, to describe the more prominent by-products,

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COMPARISON IN THE VALUES REALISED FOR A STEER AS HANDLED IN A PUBLIC ABATTOIR, COMPARED WITH THE PRIVATE SLAUGHTERHOUSE.*

Public Abattoir.

Cost—Small Steer, £21.

	£	*s.*	*d.*
1. Beef, 700 lbs. at $5\frac{7}{8}$*d.* per lb.	17	2	$8\frac{1}{2}$
2. Edible Offal	0	15	0
3. Hide and Skin, 82 lbs. at $6\frac{3}{4}$*d.*	2	6	1
4. Fat, 43 lbs. at $2\frac{1}{2}$*d.*	0	8	$11\frac{1}{2}$
5. Belly and Feet	0	4	7
6. Intestines	0	2	0
7. Blood	0	0	3
8. Gall	0	0	2
9. Lymphatic (and other) glands	0	0	3
	£21	0	0
	20	12	$4\frac{1}{2}$
	0	7	$7\frac{1}{2}$

Private Slaughterhouse.

Cost—Small Steer, £21.

	£	*s.*	*d.*
Beef, 700 lbs. at $5\frac{7}{8}$*d.* per lb.	17	2	$8\frac{1}{2}$
Edible Offal	0	15	0
Hide and Skin, 82 lbs. at $6\frac{1}{2}$*d.*	2	4	5
Fat, 43 lbs. at $1\frac{3}{4}$*d.*	0	6	3
Belly and Feet	0	3	0
Intestines	0	1	0
Blood	Nothing.		
Gall	Nothing.		
Lymphatic (and other) glands	Nothing.		
	£20	12	$4\frac{1}{2}$

* Quoted from "Some Points on the Economic Advantages of Public Abattoirs."

and so by that means illustrate that the subject is a vast one.

Blood.—The first by-product to be obtained from a carcass is the blood, and its uses vary considerably in different countries. In some Continental countries it is utilised for the manufacture of feeding stuffs, which are given to pigs, horses, and poultry. The general practice is to utilise the blood for the manufacture of blood albumen, which is used for a variety of purposes, such as the clarifying of sugar, the fining of liquors, and in dyeing. When the albumen has been separated out—a process which is conducted merely by coagulation—a clotted residue remains, and this is dried into an impalpable powder for the purpose of being used for fertiliser, and as such is worth about £6 per ton.

Fat.—Next in importance to the blood is the

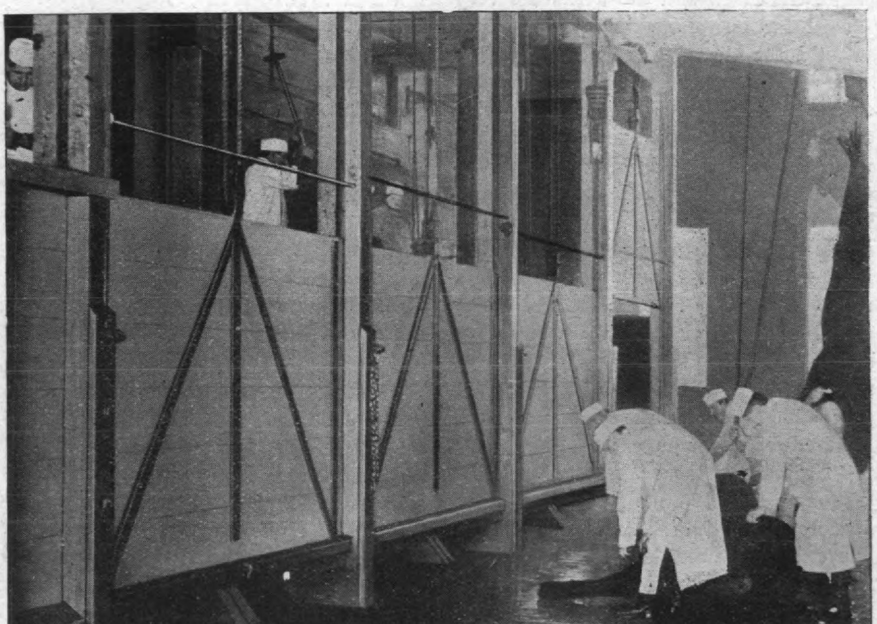

FIG. 8.—INTERIOR OF AMERICAN ABATTOIR.

Showing the knocking-down pens in which all cattle are stunned before being bled. As soon as they fall in the knocking-down pen they are rolled out on to the adjoining floor, and are at once hoisted to a rail on which they are bled.

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fat, which forms a large portion of the animal weight. Such fat as is not included in the carcass and sold as meat may either find its way to the tallow renderers, or it may be rendered as suet, an article for which there is at present a large demand, and which can only be made from the freshest of material. Another outlet for fat, and perhaps the most important of all, is in the manufacture of margarine, in which case the oleo which forms part of the fat is separated from the stearine, and this latter is used for a variety of purposes, much of it finding its way into lard compounds, which possess the advantage of not being made from lard at all! The residual matter from the fats is carefully preserved and utilised as poultry foods, so that in this department of the business there is no waste whatever. In many of the packing houses in other countries, soap-making, as a continuation of the fat rendering processes, is carried on very extensively, so that the best possible use can be made of this important by-product. Candles also are produced in many factories from the stearine, and enable a very high price to be ultimately realised for this product.

Hoofs, Horns, and Hides.—The hoofs, horns, and hides of cattle form very important raw materials in a department by themselves. The coverings of the hoofs and the horns are very largely used for button-making, the residues being utilised for the manufacture of yellow prussiate of potash, so largely used in the making of the colour Prussian Blue; but the contents of the hoofs and horns find another outlet in the manufacture of gelatine and glue, for which purpose the trimmings of the hides are also utilised, and the finer jellies and gelatines are manufactured largely from such products and used for food purposes. The hides themselves are generally treated by hide merchants, whose business it is to select them and salt them, so preparing them for the tanner, who separates the hair from the hide, the hair being largely used for mixing with lime, and the hides being, of course, utilised for the manufacture of leather.

Bones.—Necessarily, there is a large quantity of bones produced where a number of cattle are handled, more especially if sausages and similar products are manufactured. Bones, in that case, are set free to a very considerable extent, and while they may be utilised on the small scale for grinding in the green state for poultry feeding, they are best utilised by digesting them and so extracting the fat which they contain and also the gelatine. The residue can then be ground up, and forms, as bone meal or ground bones, one of the best permanent fertilisers we use on the farm. Knife-handles, buttons, and ornaments are largely made from shank bones.

Sausage Casings.—Not the least important of the by-products of the cattle are the sausage casings, which, however, can best be handled in the aggregate in abattoirs, and where weasands, which form the lining of the throat, the middles, which form the larger intestines, are all properly assorted and cleansed, so as to be used for various purposes.

All the intestines are utilised for the manufacture of different kinds of sausages, and in some countries the number of different types of sausages which are made from cattle casings and beef is very great. That is an industry which seems to have developed largely on the Continent of Europe and in America, but it seems slow to move in this country.

Tripe.—The stomachs of cattle form a very valuable commodity, and are converted into tripe for edible purposes, being cleansed by hand and by machinery, and with the addition of lime. Tripe cleaning, however, is best conducted on the large scale, so that mechanical appliances may be utilised, and the item of labour reduced to a minimum. On the large scale also it goes without saying that the cleansing processes will be much more reliable than they can possibly be in the smaller way.

Pharmaceutical Preparations.—In some of the packing houses, in America especially, quite a large development has taken place in the preparation of pharmaceutical products, such as the pepsin and rennet from the stomachs of calves, and pancreatin, which is the secretion of the pancreas. The preparation of the thyroid and suprarenal glands is also extensively carried on, and the products find valuable uses in medicine.

Condemned Carcasses.—One of the results of the meat inspection of the present day is that we have a large number of carcasses condemned as being unfit for human food. In some countries it is common to destroy such portions of carcasses as may exhibit local signs of disease, reserving the remainder to be cooked and served as cooked meat for the abattoirs. This is especially common in Germany, and the cooked meat so obtained is served out in the Friebank, which is simply a shop attached to each public abattoir. In this country we do not take this view of the matter, and the condemned carcasses have necessarily to be treated so as to render them harmless, the general practice being to convert them into fat, which is used for soap-making, and a dry impalpable powder, which, as it is

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sterile in itself, may be used for feeding purposes or simply as a fertiliser.

THE PICKLING OF MEATS.

There is a wide field in connection with the pickling of meats, not only in the curing or corning of beef, but in the curing of ox tongues, such as are so much in demand in this country, and which are so largely imported from abroad. Pressed beef is one of the commodities which is largely sold in this country, and its preparation is quite an art. In Scotland also the preparation of beef hams is at present a very considerable industry, and is one of the many smaller businesses in connection with the handling of a bullock which could with advantage be developed more largely.

Sausages.—There is also all over the United Kingdom quite a large trade carried out in beef sausages, and their preparation, although requiring some skill, is a comparatively easy matter, and there are not wanting text-books on the preparation of these and cognate products. It would be quite idle to attempt to give an account here of any one process in detail, as it would take much too long.

THE NECESSITY FOR ORGANISATION AND EDUCATION.

From what has been said, it will be seen that the bullock is capable of supplying a large number of products which are not manufactured at all in this country, and the reason would seem to be that there are no organised central packing houses, and even the abattoirs which exist are not so designed as to develop the specialisation of all these products from the three million cattle which we slaughter every year. It is entirely a matter of organisation and education. There would seem to be a necessity for the establishment of packing houses in this country, and there is every likelihood that such undertakings would be highly remunerative. Failing that, abattoirs could be made more profitable than they are at present, if they were so constructed as to utilise the whole of the by-products in them. I have seen an organisation of this sort at work in Hungary, where, at the leading abattoir, the whole of the by-products are appropriated by a society composed of the meat purveyors. These are manufactured into various products, and *pro rata* the profits are divided amongst the meat purveyors who compose the society. Something of that sort would be of immense advantage in the large centres of this country, but it would also be an enormous advantage if the ordinary meat purveyor could have opportunities for obtaining technical knowledge which would enable him to appreciate and to deal with these by-products in the same way as they are dealt with in other countries. It is quite idle to say that meat purveyors would not take advantage of these facilities. I have had the honour of putting that question to the test, and know that where such facilities are provided, they are taken advantage of with the greatest possible enthusiasm. The spirit of the age is towards progress, and I do not see why the meat industry should not be raised a step higher than it is; and this could easily be accomplished through our agricultural colleges, of which there are twenty-two in the United Kingdom, but whose system of education at the present moment stops at the very point where the exercise of the meat purveyor's art begins. It is a question for the Minister of Agriculture, and is also a question for the National Federation of Meat Traders' Associations, and I would commend the proposition to both, with the belief that it would be a step in the right direction.

THE FIRST INTERNATIONAL CONGRESS FOR THE PREVENTION OF INDUSTRIAL ACCIDENTS.

The first International Congress for the Prevention of Industrial Accidents was opened in the Castello Sforzesco, in Milan, on May 27th, 1912, the subsequent meetings being held in one of the King's Palaces (Villa Reale).

The proceedings were opened by an eloquent speech from Professore L. S. E. Luzzatti, late Prime Minister, and one of the honorary presidents of the Congress, who traced the growing interest taken in the care of the worker and industrial hygiene with advancing civilisation. Signor L. Pontiggia, the acting president, to whose initiative much of the recent attention given to industrial hygiene in Italy is due, gave a brief history of the Congress. He explained that the meeting was to be of an entirely informal nature, the idea being to bring together manufacturers, associations for prevention of accidents, insurance companies, and hygienic authorities to exchange views in a friendly spirit. In this way agreement could be reached as to directions in which reforms of real value to employer and employee might be made without any attempt to set up burdensome or premature legislations. Finally, Signor Battaglieri, Under-Secretary of Posts and Telegraphs, in the name of H.M. the King of Italy and the Government, declared the Congress open.

The Congress was attended by nearly 450 delegates and members. Several Governments were officially represented. Among others who were present mention may be made of—Great Britain: Mr. C. W. Bowerman, M.P. (Secretary of the

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Trades Unions' Parliamentary Committee), Mr. S. Smith (representing the Home Office), and Mr. L. Gaster (delegate of the Illuminating Engineering Society). United States: Dr. W. Tolman (representing the United States Navy and Director of the Museum of Public Safety, New York). Italy: Commandant Dottore V. Magaldi, Professore A. Menozzi, and Signor F. Massarelli (general secretary). France: Monsieur J. Bocquet (Ingénieur-en-Chef de l'Association Normande pour prévenir les Accidents du Travail), Monsieur Boulisset (Inspecteur divisionnaire du Travail dans l'Industrie, Paris). Germany: Commandant Hans Breiter (German Consul in Milan). Belgium: M. Deladriere (Directeur de l'Association des Industriels, Belge). Portugal: Signor J. Magalhaes, etc.

The subjects considered at the Congress were grouped in seven sections:—

1. Handling and mounting of belting on running machinery.
2. Fencing of rolling machinery for metals, rubber, etc.
3. Ventilation arrangements to eliminate the fine dust, etc., in the cotton industry.
4. Methods of eliminating steam and vapour in dyeworks and similar factories.
5. Precautions in the design and use of centrifugal hydro-extractors (drying machinery).
6. Precautions against accidents from leakage of electricity to earth.
7. Various unclassified contributions on industrial hygiene and safety appliances.

In the first section attention was mainly concentrated on the safe handling and mounting of belts on pulleys. Several devices and suggestions were described showing how to reduce greatly the accidents from shafting and mill-gearing. The most important point was to effect the mounting of belts with perfect safety without its being necessary to stop the machinery.

In Section II. a great deal of attention was given to rolling machinery, and devices were described for preventing the possibility of an inattentive operator getting a part of the body drawn between the nips of the rollers. Proper fencing is particularly essential in the case of such machinery when used in non-engineering works (*e.g.*, in laundries, bakeries, biscuit manufacture, etc.), since the attendants in such cases, while intimately acquainted with the details of their own trade, frequently are not very conversant with mechanical appliances. A most interesting paper on this subject was read by Signor F. Massarelli, illustrated by a number of diagrams suggesting convenient methods of protection.

In Section III. quite a number of papers were presented, dealing with the importance of removing fine dust in the stripping and grinding of cotton, in carding engines and other processes used in spinning of hemp and flax. This dust is injurious to health if inhaled, causing a good deal of respiratory disease. In the well-organised cotton industry, manufacturers now recognise the value of efficient machinery for sucking in and disposing of such dust. Not only is the health of workers safeguarded, and the losses through compensation, irregular attendance, etc., reduced, but the material itself is greatly improved. In this section special mention may also be made of the contribution by M. Axel Schäffer (of the Maison F. L. Smidth & Cie, Copenhagen), giving a most instructive account of the method employed of filling sacks and barrels with cement by a special suction process.

Another matter which came up for consideration was the artificial humidification of cotton in spinning factories and weaving sheds. The importance of pure water being used for this purpose was emphasised in the papers and in the discussion which followed. It was stated that infectious diseases were apt to be propagated by contaminated water, and the desirability of fixing a standard of purity was considered. As the rules of the Congress did not permit a vote being taken on such questions, no definite decision could be framed. However, opinion on this point was quite unanimous. It is of interest to mention that such a standard has actually been embodied in the regulations which recently came into force in England, which shows how advanced the authorities in this country are on this matter.

Papers on this subject were contributed by representatives of Austria, France, Germany, Italy, Switzerland and Belgium.

In Section IV. a number of papers were read on the removal of steam in dye-works, hat and cap manufacture, silk mills, etc. The latest devices in the use of fans were described by representatives of France, Italy, and Switzerland. It was pointed out that the continual presence of steam and water-vapour in the atmosphere was distinctly prejudicial to the health of workers. It lowers the energy of the body, and thus interferes with work, and also leads to digestive troubles. It was further stated that exposure to these conditions predisposes the body to offer less resistance to the action of microbes.

In Section V. the manipulation and design of hydro-extractors was very fully discussed. The rotation of machinery at high speed in order to dry materials by centrifugal means is obviously dangerous when mechanical weaknesses are present, and some of the types described were considered imperfect in this respect. An important matter in the use of such machinery is the even distribution of the charge. Occasionally it has happened that the mass treated has become concentrated at one point in the rotating vessel, and the unequal strain set up has led to a breakdown while the apparatus was in motion, with very serious consequences. Signor Massarelli's paper in this section, dealing mainly with the use of centrifugal apparatus in sugar refineries, contained several valuable suggestions for the avoidance of such dangers, and also for automatic covers or lids for these machines.

In Section VI. considerable attention was given to safety in electrical earthing devices, official reports by delegates from Italy (Professore G. Motte), Germany (Herr C. Seidel), and France (Monsieur G.

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Baigneres), being presented. Several other contributions, including a paper by Signor G. Rebora, were read in abstract. The existing regulations in England dealing with this subject have been quoted as worthy of imitation.

The papers in the Miscellaneous Section were mainly concerned with special branches of research. A useful suggestion was made by Dr. W. Tolman (United States), that it would frequently pay large works to utilise the services of a special expert in factory hygiene, whose duty it would be to keep his employers informed of all recent regulations and safety devices, and to recommend their adoption when necessary. Such an expert, called a "safety engineer," could act as a connecting link between the authorities and the owners of factories, and would be able to appreciate the views from both quarters and to smooth the way for genuine reform. This suggestion has already been made with reference to the pottery industry in England. In course of time it will, no doubt, be extended to other trades, and "safety engineers" may become a common feature in all countries. Another interesting suggestion made by Mr. Villain was that there should be agreement on some form of international danger signal. It is not suggested that this signal should supplant the regulations regarding guards, but should be used to indicate dangerous spots or passages so as to avoid accidents as much as possible.

Among the other papers in this group, special reference may be made to those dealing with the necessity for adequate illumination in factories. Mr. Gaster, a delegate of the Illuminating Engineering Society, pointed out that good light was now coming to occupy a similar position to ventilation, fresh air, and proper sanitation, and in this view he was supported by the Congress. It was desirable not only to frame some standard of the amount of illumination required for various purposes, but also to consider the proper position and distribution of lights. Instances were quoted to show how bad lighting led to accidents—a view substantiated by the recent departmental committee on accidents in this country. The Home Office in Great Britain are now paying special attention to the matter, and an important step has recently been taken in France in appointing a special committee on the hygienic aspects of lighting. The Home Secretary has promised a departmental committee on the same subject in England, and it is hoped that other nations will also take this step so as to ensure international co-operation.

A paper by Mr. V. R. Lansingh (President of the American Illuminating Engineering Society), which, in the absence of the author, was formally presented to the Congress, also advocated the claims of good illumination. Special reference was made to the work of the National Association for the Conservation of Vision in that country, and a series of illustrations were presented illustrating the proper arrangements of lights to avoid "glare" in the eyes of the worker. One point on which general agreement was expressed was the desirability of actual measurements of illumination in the factory, and it was explained that such measurement was now looked upon as quite a simple and practicable process.

It only remains to add that beside the papers read a series of visits were paid to factories in the neighbourhood which were regarded as models in their arrangements for health and safety. It is a good sign that both employers and representatives of the Governments are alive to the importance of industrial hygiene and are prepared to work together. The employer now recognises the economic importance of keeping down sickness and accidents to a minimum, and is willing to welcome suggestions as to how they can be avoided.

It is the object of these Congresses to pave the way for friendly agreement on measures which are desirable both from humanitarian and utilitarian motives. Many reforms which were originated mainly with a view to improving the lot of the worker have also proved to be well worth while as a pure matter of business. It is clearly an advantage to secure international co-operation in these matters so that manufacturers in one country may receive the benefit of improvements which have been shown to be incontestably desirable in another, so that all may work under similar conditions and in fair competition.

The name of the acting president of the Congress, Signor L. Pontiggia, deserves to be remembered and connected with the initiation of this movement for improving industrial health and safety, and acknowledgement should also be made of the services of the capable general secretary, Signor F. Massarelli. It may be added that Italy has for some years taken a conspicuous part in this work, and the special institute devoted to industrial hygiene in Milan under the care of Professore Devoto, is the first of its kind in existence.

The next Congress is to take place in 1915 at Paris, and no doubt by that time there will be important advances to record.

L. GASTER.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Condition of Trade.—In respect of the influx of new business the markets vary, but in one vital particular the industries of the textile group are much alike. They have in general plenty of work in hand, and so are above the necessities of a moment. Makers are not immediately able to get the advances they would like, but their affairs in general are healthy. Manchester is industriously recouping itself for the series of lean years. Bradford finds some life still left in its protracted boom. Dundee is very firm and able to command high prices for fine yarn. Belfast is entrenched securely behind walls of orders for linen cloth. Even the trades which are in between seasons are not described as dull, and the business in woollens

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called by the name of shoddy, is especially lively. In all, reports from British centres contrast favourably with those from any manufacturing country, and the financial results recorded are almost uniformly good. The textile industries do not invariably flourish in harmony, for some of the parts are mutually antagonistic, but they come very near to perfect unison at the present time.

Artificial Cotton.—As one of the cheapest of fibres, cotton presents relatively a slender front to the inventor of artificial substitutes. The sale for a satisfactory substitute might be taken as infinitely large, but with Middling American at something under 7*d.* per lb., the available margin for working expenses is manifestly restricted. Cotton of this quality can profitably be grown for less than the market price of the present, and it has sold for less than half the money. Even assuming that the cotton produced by chemical or other means served the purpose of fine long-staple material, worth one shilling, it is still evident that a practicable process would have to employ an inexpensive base and reagents. If it be asked what such a process would be worth, there is the evidence in a Paris police-court case for an answer. Signor Crespi, manufacturer and Deputy of Milan, had agreed with a Manchester firm to sell the patents for a process of making fine cotton for £400,000. The arrangement was presumably provisional, and now that one of the inventors has been convicted of supplying beforehand the cotton that he professed to manufacture, it is to be presumed that little more will be heard of the business. The reward mentioned may be large enough to induce others to persevere in the face of the economic difficulty. Hitherto nothing—natural or artificial—has taken cotton's place or given substantial promise of doing so. There have been attempts to foist rivals into prominence, and presumably most persons have heard of the extravagant claims made on behalf of ramie. But cotton is cheap to work as well as to grow, and one can buy, manufacture and sell cotton yarn for as little as it costs simply to work ramie. With Middling cotton quoted 6·60*d.*, yarn is quoted $9\frac{9}{16}d.$ for 32's weft, and $10\frac{1}{16}d.$ for 32's twist. The prices give an idea of the economy of the operation. Some American figures secretly obtained in Lancashire by agents of the Tariff Board may not be unchallengable on the score of accuracy, but they go to show that the total cost of converting raw cotton into yarn measuring thirty times 840 yards per lb., is from $1\frac{1}{4}d.$ to $1\frac{3}{8}d.$ per lb., in seven Lancashire mills. A cost of 1·749*d.* per lb. is given in Mr. Winterbottom's "Cotton Calculations," as the average of the Oldham district.

Ramie.—Except in conjunction with incandescent gas-mantles the name of ramie is little heard in these times. For reasons probably connected with its high absorptive properties ramie answers admirably for this purpose. After the match has been applied to the impregnated mantle and the carbonaceous structure has been removed, a strong crust of luminous metallic salts remains. As a single pound of ramie yarn is computed to make some five or six gross of mantles, it is obvious that the aggregate weight of raw material required to satisfy the lighting industry is relatively small. Even in this field ramie has a more or less serious rival in moulded mantles made by dissolving and precipitating cellulose in a manner akin to that by which artificial silk is made. Apart from a narrowly limited range of uses ramie remains easily the most consistent disappointment in the whole family of textile fibres. More money has been sunk in its development to less purpose than in anything that has engaged English attention. According to estimates, which nobody contradicts, some thirty millions have been lost in ramie by planters and manufacturers during fifty years. One German undertaking, succeeding where virtually everyone else has failed, pays good and regular dividends out of ramie manufacture, but otherwise, the industrial history is a story of unrelieved disaster.

Huddersfield Worsted.—The projected visit of the King to one of the most famous worsted cloth mills in the world may be expected to have some influence on the public. Wearers of suits accept their Huddersfield worsteds as a matter of course, usually without inquiring how or where they came into being, and without the remotest conception of the pains that have been taken to make the cloth perfect. It is the special function of the high-class Huddersfield firms to clothe the West-ends of most capitals with fabrics for dress-suits, the fancy trouserings which tailors call "cashmere," and the unimpeachably neat greys which are generally worn in the absence of Scotch tweeds. Huddersfield has some assistance from surrounding neighbourhoods, and from the West of England in this task, but all that can be done by the best designers, weavers, and finishers using the best materials at command, is done in Huddersfield. More is spent there in producing new worsted patterns than in the whole of the rest of the world, and if fault can be found it is that the goods are faultily faultless, too austerely reticent in colouring, and exquisite in woven effect. Periodically there is a reaction from the monotony of irreproachable style, and the fashionable turn to the bolder and rougher tweeds. The ordinary wearer never discovers that it has taken a combination of six shades of grey to produce the particular tone prevailing in his suit, and has no suspicion that anybody spent days in working out an infinitude of permutations and combinations to arrive at the ultimate result. Any notion that the production of a single inch involves more than one hundred, and perhaps over two hundred passages of the shuttle is, of course, absent. In the instance of a blue cloth of an uncommonly fine quality made near Huddersfield, seven pounds of the finest Australian wool has to be bought in order to find a single pound of wool fine enough for the purpose.

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Colne Valley Tweeds.—The accounts do not make it clear that His Majesty is to enter any of the very different mills which exist to feed the machinery of the wholesale clothing factories. Huddersfield stands at the confluence of the Holme and Colne Valleys, and along the steep sides of the latter are the mills producing the famed Colne Valley tweeds. It is for smartness and insuperable cheapness that these goods are renowned, and it is due to Colne Valley skill in imitating the appearance of high-priced tweeds that Scotch and Irish tweeds are seldom fashionable wear for long amongst ladies. The mistress finds that the servant has bought for a very few shillings a fair replica of a costume for which she paid nearly as many guineas. The larger part of the goods are for men's wear, and many of them are overcoatings. They are light or dark, soft or cheviot-like in handle, according to the seasons, and at present many are slavishly faithful copies of the well-known Donegal cloths. They range in wholesale price from 1*s*. 4*d*. to 2*s*. 9*d*. a yard, the cheaper ones contain cotton, and wear the better for it, and the higher qualities contain a good deal of stocking wool. The chief raw material is pulled hosiery, costing 4*d*. or 5*d*. a pound, and the virgin wool used is largely "locks and pieces" from the floors of Colonial shearing sheds. Between them, the mills use any and every sort of wool waste, and have no superiors in their own line in turning unpromising material to advantage. The goods appear in every cheap clothier's windows throughout the British Isles, and they go in quantity to Canada, Australia, South America, the East and the Continent. Some German goods approach them in value, but the Colne Valley is unbeaten or unbeatable. Its mills run night and day for long periods together, and no reviling of its goods as shoddy disposes of the fact that it gives people what they want at the prices they can pay.

Spun Silk.—A remarkable change has come over the English silk-spinning industry within the last ten years. In that space of time the trade has advanced from the depths of depression to a sound state of prosperity, despite the decay of that which was its main support. No statistics record the gradual contraction of the demand for white yarn, and the substitution of a new demand for tussah silk. The change is none the less a fact, and those with opportunities for forming an accurate judgment estimate that four times more tussah is now being spun than in the first years of the century. The trade in China and Italian qualities has been filched away apparently by mercerised cotton and lustracellulose. Simultaneously there has grown up a convenient demand for yarn spun from the waste formed in reeling the brown cocoons of the oak-feeding silkworm. The taste for tussah summer clothing is apparent on all hands, although it is to some extent met by cotton and flax and cotton imitations. Again, there is the fashion for seal plushes in which the pile is tussah silk, and there is a certain trade in tussah cloth for the wear of miners in hot climates. The very by-products of the tussah industry have been commanding a high price, and the decision applying a prohibitively high duty to tussah noils of the longer sorts entering the United States has had comparatively little effect on prices. The Americans were mixing these noils with wool to make a fleecy face upon overcoatings. There is now a good consumption of the noils upon the Continent, where they are recombed and spun. Should misfortune overtake the business in tussah yarn a difficult predicament might arise, in course of which spinners might have to take more seriously into consideration the advisability of adopting Continental methods of work. Proceeding by the "schappe" or fermentation process, which does not remove the whole of the silk gum, the Continental spinner is enabled to produce a yarn of even surface from short, and consequently cheap, material, and it is a simple fact that the Italians are selling single yarn in the English market with which yarns made by the traditional English method are entirely unfitted to compete.

NOTES ON BOOKS.

Répertoire de Couleurs pour aider à la Détermination des Couleurs des Fruits, des Feuillages, et des Fleurs. Publié par la Société Française des Chrysanthémistes. London: The Royal Horticultural Society.

The necessity for a standard for the discrimination of colours has long been felt, and at different times attempts have been made to provide such a standard. In 1891, the council of the Society of Arts appointed a committee to consider the practicability of formulating a standard of colour for industrial purposes. This committee, after some discussion, decided on a preliminary or provisional list of names for standard colours, and selected a series of tints which they considered were represented by those names. It was proposed to prepare, by means of the colour-patch system invented by Sir William Abney, a formula for each of these tints, by means of which a patch of light, accurately representing the tint, could be reproduced at any time or place. There is no doubt that if such a standard could be successfully established, and if a sufficient number of different hues could be thus named and standardised, such a standard would be of very great value for many purposes. But the labour of examining a sufficient number of different colours, and of determining with accuracy the formula for each colour, would be very great, and, unfortunately, the excellent intentions of the committee were never carried into effect.

Some time ago, the French Chrysanthemum Society undertook to discriminate and to name a number of different colours, with the idea of

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providing gardeners and florists with the means of recognising and discriminating the precise colour of any possible flower. The French Society, perhaps wisely, did not attempt anything like a scientific classification, but were satisfied to select a number of colours, to give them names, and to reproduce, by printing upon paper the colours they had selected. It is obvious that such a standard is very far from being an ideal one. Colour prints upon paper fade and change, and there is no doubt that in a few years the samples provided by the French Society will have altered considerably in character. There are also other questions to be considered, such as the difference in colours resulting from difference in texture of the coloured surfaces, and also the different appearance presented by identical colours seen upon a background of the same or of a different tint. But when scientific accuracy is not sought, and all that is wanted is a means of approximately identifying different hues, there can be no question whatever that a list such as has been provided by the work of the French Society is of very great value. Recognising this fact, the Royal Horticultural Society have obtained a stock of the prints published by the French Chrysanthemum Society, and are offering them at the moderate price of 14*s*. 6*d*. to their Fellows.

There appear to be altogether 365 different colours which have been selected, and to each of these a name, more or less appropriate, has been given. Each of these colours is printed in four shades, making in all 1460. The names selected are purely arbitrary, and it would be easy to criticise a good many of them. But this, perhaps, does not very much matter, as each colour or shade has a number, and can be at once identified. The colour-names originally selected were in French, but corresponding names in German, English, Spanish and Italian are also supplied.

THE PAINTERS' POCKET-BOOK. By Arthur Seymour Jennings. London: The Trade Papers Publishing Co., Ltd. 3*s*. net.

The public appreciation of this practical guide for painters and decorators is amply proved by the fact that it has now reached its third edition. In its present form it is much enlarged, the number of its pages having been increased from 156 to 252; but it is still so handy that it can easily be carried in the pocket. In spite of its convenient size, however, it contains an immense amount of information. After dealing with tests for pigments, it describes how to measure painters' work; this is followed by a long section on prices, and another on defects in painting and the remedies therefor; and the book concludes with a number of tables of wages, prices, etc., which should be of daily use to the painter and decorator. Not the least valuable part is a concise dictionary of terms used in painting, building, architecture, art, applied chemistry, etc. Many of these terms are explained by illustrations, most of which are useful, but in some cases they are too small to be of much service: *e.g.*, no one who did not know beforehand what a raised panel was, would be able to deduce the information from the picture. To some of the illustrations, again, there is no reference in the text; *e.g.*, the word "pinnicle." This, doubtless, under its more usual spelling, is sufficiently familiar to require little explanation, but as much cannot be said of the word "swag," nor does the illustration do much to lighten the darkness of the uninitiated. These, however, are but very small points, and they are only mentioned in order that they may be corrected in the next edition. The bulk of the book is written by Mr. A. S. Jennings, the well-known editor of *The Decorator*. There are also special contributions by Mr. Noel Heaton, who recently delivered before the Royal Society of Arts a course of Cantor lectures on "The Materials and Methods of Decorative Painting," and Mr. Charles Harrison, Lecturer on Painters' Oils, Colours and Varnishes, at the Borough Polytechnic.

GENERAL NOTES.

NATIONAL CONGRESS ON REFRIGERATION AT TOULOUSE.—The second National Congress on Refrigeration will be held at Toulouse on the 23rd, 24th and 25th September next. Organised by the Association Française du Froid, it will, as its title implies, embrace everything that relates to refrigeration and the use of artificial cold in agricultural and other industries. Excursions will be made by the members of the Congress in order to visit some of the principal centres of wine production in the south of France, where the latest applications of refrigeration in connection with this industry are in use. Another excursion will be made to Roquefort, where artificial cold is successfully used in the manufacture of the celebrated cheese of that name. A visit will also be made to the agricultural exhibition at Bourges, where, under the auspices of the Automobile Club a special section for freezing apparatus will be opened.

NUMBER OF BICYCLES IN FRANCE, 1911.—The number of bicycles in France appears to be on the increase, judging from the latest returns for 1911, which gives a total of 3,009,626 as compared with 2,697,406 of the previous year. The total revenue from the tax on bicycles last year amounted to upwards of nine millions of francs (£360,000), or about half a million francs more than in 1910. The ten departments having the greatest number of bicycles last year were those of the Seine, with 309,759; Nord, 159,656; Seine-et-Oise, 97,271; Gironde, 75,390; Pas-de-Calais, 70,610; Seine-Inférieure, 62,997; Maine-et-Loire, 60,265; Saône-et-Loire, 58,595; Seine-et-Marne, 55,594; Loiret, 54,510. The department with the smallest number was that of Lozère, with only 2,920 cycles.

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Journal of the Royal Society of Arts.

No. 3,112. VOL. LX.

FRIDAY, JULY 12, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday, the 8th inst., at their first meeting, the Council re-elected LORD SANDERSON, G.C.B., K.C.M.G., Chairman for the ensuing year.

PRACTICAL EXAMINATIONS IN MUSIC.

The Practical Examinations in Music were not concluded this year until the 3rd inst., too late for the results to be included in the Report of the Council. They lasted for eight days.

The examinations were conducted by Dr. Ernest Walker, M.A., and Mr. Burnham Horner.

The system of examination was the same as that for recent years. For instrumental music certain standards are given, and candidates are asked to select for themselves which of these standards they choose to be examined in. The standards range from easy to very difficult music. For each standard a list of music is given for study, and from this list candidates select the pieces they will sing or play. Candidates are expected to play or sing the pieces which they have prepared, to play or sing a piece, or portion of a piece, at sight, and to play certain scales.

In all, 300 candidates entered, and of these 296 were examined, an increase of 13 as compared with last year. There were 220 passes and 76 failures.

The following were the subjects taken up:—Piano, singing, violin and violoncello. 239 entered for the piano, 176 of whom passed; 45 entered for the violin, of whom 35 passed; 2 entered for the violoncello, 1 of whom passed; 10 entered for singing, of whom 8 passed.

The examiners report that the average quality of the pianoforte playing in the less advanced standards was better than last year, particularly as regards touch. In the other departments of the examination there was no noticeable change. Several of the candidates were ill advised in attempting standards which were as yet beyond their technical and interpretative powers.

THE ROYAL SOCIETY OF ARTS.*

By SIR HENRY TRUEMAN WOOD, M.A.,
Secretary of the Society.

IX.—THE SOCIETY AND FORESTRY.
(1758–1835.)

As far back as the Restoration complaints had been rife of the lack of timber. Wood was almost the only fuel. It was one of the principal materials for construction on land, and the only one available for naval purposes. The forests which once covered the country had been cut down, and the timber used for a thousand purposes, of which the most important were shipbuilding and iron-founding. The places where the iron manufacture was located were decided, not as now by the existence of coal, but by the neighbourhood of forests. Sussex and the Forest of Dean were the chief centres of the iron trade, not so much because of the abundance of iron ore, but because of the abundance of wood. Sheffield became the chief seat of the cutlery business because it was surrounded by forests; and as the wood was used or burnt no efforts were made to replace it.

In or about 1662 the Navy Office, alarmed at the increasing lack of timber for naval purposes, applied for advice to the Royal Society, who

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, and November 3rd, 1911, January 12th, 19th and 26th, April 5th, and June 14th and 21st, 1912.

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passed on to John Evelyn the questions they had been asked. The result of his investigations was the well-known book, "Sylva, or a Discourse of Forest Trees and the Propagation of Timber in His Majesty's Dominions."* In it Evelyn appealed to the landowners to improve their forests and woods, and, paraphrasing the words of Nehemiah, he cried, "Let us arise then and plant." "To you princes, dukes, earls, lords, knights, and gentlemen, noble patriots (as most concerned), I speak to encourage and animate a work so glorious, so necessary." It is doubtful whether this remarkable book, which has become an English classic, had any very great practical or permanent effect, though the author was able to boast that "many millions of timber trees have been propagated and planted at the instigation and by the sole direction of this work."

At all events, things were no better a century after Evelyn's time, though the use of "sea-coal" for fuel had increased, and it was applied for various manufacturing purposes. Iron, however, still had to be made with charcoal, since it was only about 1730 or 1735 that Abraham Darby first succeeded in employing coke for the purpose, and about 1750 that he had established the manufacture on a commercial basis. For many other manufacturing purposes, coal, with its sulphurous fumes, was not considered suitable, and nearly all over the country wood was still the only domestic fuel. Not only were the trees cut down, but they were either pollarded or stripped of their branches. Arthur Young, in his "Farmer's Letters," says that in many parts of the country the result of this practice had been to convert the trees into "May-poles."

Attempts had been made by legislation to limit the use of wood for fuel, but apparently there had been no serious efforts to replace the stock of timber by acting on the principles laid down by Evelyn, until the Society of Arts took up the question.

The first suggestion came from Mr. Henry Baker, who, according to the minutes of the meeting of March 26th, 1755, presented to the Society from the author, Mr. Edward Wade, "a quarto pamphlet published by him to promote the planting of timber trees in the common and waste ground all over the kingdom for the supply of the Navy, the employment and advantage of the poor as well as the ornamenting the nation." This led to the inclusion in the 1758 prize list of three premiums for tree-planting. A gold medal and two silver medals were offered for sowing the greatest quantity of land with acorns (five acres at least), four bushels to the acre. Similar premiums were also offered for planting Spanish chestnuts, elm, and Scotch fir. In 1759 the same prizes were offered, with the addition of similar awards for Weymouth pine, "being the properest sort for masts." As time went on various additions were made to the list, and the conditions were varied, but not very widely. Eventually the list included besides oaks, which were to be planted as well as raised from acorns, and the trees above mentioned, red Virginia cedar, spruce fir, silver fir, larch, Norfolk willow, alder, red willow, ash, Lombardy poplar, elm and walnut. At one time, about 1795, a special prize was offered for oak trees in "compass forms" for shipbuilding, but this elicited no response, and the offer was dropped.

The first award was in 1758, when a gold medal was given to the Duke of Beaufort for sowing twenty-three acres in Hawksbury, Gloucestershire, with acorns.* In 1761 the Duke of Bedford received a silver medal for sowing eleven acres with acorns at Woburn, and in 1763 a second similar medal for 16,000 Scotch firs planted at Millbrook, Bedfordshire. In 1761 Earl Winterton had a gold medal for sowing twenty acres near Plaistow with acorns. Lord Winterton also received another gold medal in 1767 for planting 2,000 elms in Ash Park, Sussex, and two more in 1776—one for sowing acorns and the other for planting Lombardy poplars. In 1763 the Earl of Portsmouth had a gold medal for planting 6,100 small-leaved or English elms. After this date the prizes become more numerous, and the following awards were made to various noblemen for plantations on their estates: 1766, silver medal to Lord Scarsdale for planting Scotch firs; 1767, gold medal to Viscount Turnour for Spanish chestnuts, gold medal to the Earl of Moray for planting 7,646,000 oaks, firs and other trees; 1779, gold medal to Lord Paget for sowing acorns, and silver medal to the Earl of Donegal for planting oaks; 1784, gold medal to the Earl of Upper Ossory for his plantations (not specified); 1788, gold medal to the Earl of Fife

* The "discourse" was "delivered" to the Royal Society October 15th, 1662, and the complete book was first published in 1664.

* The entries up to 1783 are taken from four sources: the "Register of Premiums," 1778; Dossie's "Memoirs of Agriculture," &c., Vol. III., 1782; the list in Vol. II. of the *Transactions*, 1784; and a list in Vol. XLIX. of the *Transactions*, part ii. p. 1. These lists do not always agree. From 1784 on we have the annual prize lists in each volume of the *Transactions*.

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for his plantations in Scotland. The same nobleman got a second gold medal in 1803 for planting forest trees. In 1797 a gold medal was given to Lord Brownlow for planting osiers, but this was a special offer, quite apart from the prizes for raising timber.* Two years before, Lord Brownlow had a grant of £20 for the same thing, which was a very unusual thing in the case of noblemen, since members of the peerage were only considered entitled to honorary rewards. In 1800 the Marquis of Titchfield had a gold medal for sowing acorns; in 1803 Viscount Newark received a gold medal for planting oaks; in 1805 the Earl of Breadalbane had a silver medal for firs. In 1808 the Earl of Mansfield had a gold medal for oaks. A gold medal was presented to the Duchess of Rutland in 1816, but this was for ascertaining the best method of raising oaks, and was not a prize for planting. In 1820 the Duke of Devonshire received a gold medal for planting forest trees. The last award for plantations to a nobleman was the gold medal given to Lord Newborough in 1828 for planting forest trees.

Richard Watson, who was Bishop of Llandaff from 1782 to 1816, received three gold medals from the Society; in 1788 for larch, in 1789 for ash, and in 1808 for larch. All his plantations were on an estate which he inherited in 1786.

The awards to other landowners are too numerous to set out in detail, but some may be mentioned, on account of their comparative importance, or because of the personality of the recipient.

In 1759, a gold medal was awarded to Dennis Rolle, of Hudscot, Southmolton, for sowing about twenty-five acres with acorns, and three silver medals were given to Philip Carteret Webb, John Berney and T. Drew, for sowing smaller areas. Dennis Rolle received a second gold medal in 1761 for planting over 100,000 Scotch firs. In 1763, four gold medals in all and two silver were awarded for elms, chestnuts and fir.

In 1764 Robert Fenwick, of Lemington, Northumberland, had a gold medal for 104,000 Scotch firs. In 1765 he had a second for another 102,000, and in 1766 a third for yet another 100,000, 306,000 in all.

William Beckford, the author of "Vathek," in 1769 received a gold medal for planting 61,800 Scotch firs at Fonthill, the celebrated estate where he ruined himself by his lavish expenditure on fantastic decoration.

Richard Muilman Trench Chiswell, of Debden Hall, Essex, had a gold medal in 1776 for planting Lombardy poplars, and two gold medals, in 1777 and 1778, for planting elms. His name was originally Muilman, and he changed it on succeeding to the Debden Hall estate. He was an antiquary, and wrote on the history of Essex.

Thomas White, of West Retford, Notts, received six gold medals in 1778 for his plantations of poplar, larch, Scotch fir, occidental plane tree, spruce fir, and silver fir. He also received two gold medals in 1779 for Norfolk willow and ash, one in 1785 for elm, one in 1786 for alders, and a silver medal in 1788 for oaks, making in all ten gold medals and one silver medal.

In 1778 a gold medal was awarded to William Mellish, of Blythe, Notts, for planting 101,600 spruce firs, and in 1780 a second medal for 475,000 larches.

Lewis Majendie, of Hedingham Castle, Essex, received four gold medals for planting oaks, chestnuts and ash (two) in 1792, 1794 and 1797.

The most extensive plantations were those made by Colonel Thomas Johnes, of Hafod, Cardiganshire, a man of considerable reputation in his time. He was Lord Lieutenant of Cardiganshire, and from 1774 to 1816 he represented a Welsh constituency. He was well known as a book collector and as the translator of Froissart, Monstrelet, and other chroniclers. Between 1795 and 1801 he planted 2,065,000 trees, of which number 1,200,000 were larches. Besides this, fifty-five acres of land were sown with acorns, or planted with oaks, and it was subsequently stated that he had raised 922,000 oaks. He received altogether six gold medals from the Society, in 1800, 1801, 1802, 1805, 1810 and 1813. A special account of his plantations is given in the preface to Vol. XIV. of the *Transactions* (p. x.).

John Christian Curwen, M.P., of Workington Hall, Cumberland, received four gold medals, in 1797, 1802, 1804, and 1809, for sowing acorns, and for planting larch (two) and timber trees. In 1801 and 1802 he planted 814,000 trees. He was a member of the Society from 1798 to 1827, and a Vice-President from 1809. Besides these awards for planting, he received seven gold medals and one silver for cultivating wheat, beans, carrots, cabbages and potatoes, for draining and improving land, and for feeding cattle. In all he received eleven gold medals from the Society, which must certainly be the largest number presented to any single individual. He contributed numerous papers to the *Transactions*, and also published a good

* See *Journal*, January 26th, p. 271.

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deal on agricultural matters, and on the condition of the labouring classes. According to a statement made by himself, it was due to the Society that he first took up farming.

Dr. William Makepeace Thackeray, of Chester, received a gold medal in 1809 for extensive plantations of ash, beech, chestnut, elm, and other forest trees, and another one in 1819 for planting 188 acres with forest trees. He was a first cousin of Richmond Thackeray, the father of the novelist. The plantations, according to the account he gave of his work in the *Transactions*, were made on property in Denbigh and Merioneth, belonging to his stepson, J. M. Jones, for whom he was trustee.

Dr. Henry Ainslie received a silver medal in 1803 for planting timber trees, and a gold medal in 1812 for the same. He was a distinguished physician, Senior Wrangler, and a Fellow of Pembroke.

Charles Fyshe Palmer, M.P., of Oakingham, Berks, received two gold medals for forest trees (893,000) and oaks, and a silver one for sowing acorns—all in 1821. Before this, in 1819, he had a silver medal for planting 115 acres with forest trees.

The last award for tree-planting was in 1835, when a gold medal was given to Edward Rogers, of Stanage Park, Radnor, for plantations carried on from 1799 to 1831 by Mr. Rogers and his father. The number of trees planted was about 700,000 (*Transactions*, Vol. L. part ii. p. 1).

In all 127 gold medals and forty silver medals, besides certain pecuniary grants amounting to about £200, were given by the Society for arboriculture. Nearly all these were awarded in the period from 1758 to 1821. After 1821 there were very few awards, only seven in all. The offer of prizes was continued down to 1846, but was not renewed after that year.

It is impossible to state with exactitude the number of trees planted which these awards represent, for although, in some cases, the particulars are given in the records of the Society with extraordinary precision, in others such phrases as "extensive plantations" are used; but at the very lowest estimate this number must have considerably exceeded fifty million, of which some twenty million were firs and larches, and some fifteen million oaks.

On the whole, it may certainly be said that the attempt was extremely successful, thousands of acres were planted, and, as a practical result, the supply of timber was, to a certain extent, renewed. Many of the woods throughout the country owe their present existence to the initiative of the Society of Arts.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE MEAT INDUSTRY.

By Loudon M. Douglas, F.R.S.E.,
Technical Adviser on Animal Industries.

Lecture II.—Delivered February 12th, 1912.

The Sheep and its Products.

We now come to consider the sheep from the point of view of its use in animal industries, and at the outset it will be well to remember that there are many varieties of the sheep in different countries. In the United Kingdom alone there are some thirty-two different kinds, divided up generally into the long-woolled, short-woolled, and mountain breeds, each one having its own particular recommendation; but from the classification indicated, it will be evident that the particular characteristic of the sheep is its fleece, and that, in the development of this particular animal, more regard has been paid to the wool product than to the carcass. It will be rather difficult to make a definite classification in the breeds of sheep, as so many of the existing types are merely the result of selection and cross-breeding. The type which has undoubtedly influenced the various races to the greatest extent is the merino, which originated in Spain, and which was introduced into the United Kingdom from that country about the year 1786. The merino has been successfully crossed with many English breeds, and the immediate effect has been an addition to the weight of the carcass. It seems to be well established, however, that it is difficult to get a large produce of wool together with a large carcass. The protein of the food is utilised either for the production of mutton or the production of wool, and the plan of Nature appears to allow only the one characteristic or the other to predominate.

Statistics.

It is of interest to observe that the distribution of the sheep throughout the world is totally different from the distribution of cattle. Thus we have:—

* In Europe	160,036,801
In North America	67,771,781
In Central and South America	97,723,396
In Asia	45,758,478
In Australasia	109,492,319
In Africa (about)	60,000,000
	540,782,775

* "Statistique des Superficies Cultivées, de la Production Végétale et du Bétail," Institut International D'Agriculture, Rome, 1910.

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A notable feature of these figures is that in Australasia there are over 109 million sheep as compared with 12 million cattle, and in Central and South America there are over 97 million sheep as compared with 43 million cattle, and, as we shall see, these particular countries are our principal sources of supply for the mutton which is imported into this country from overseas.

The imports of mutton and lamb into the United Kingdom reached a total of 594,719 tons, which is equivalent to 12,960,383 carcasses, and these come from Australia, New Zealand, Argentina, Uruguay, and Patagonia; and the fact that we are dependent on these countries for such huge supplies is very remarkable in itself, seeing that the produce is derived in the first instance from British-bred animals which from time to time have been imported there.

The home supply of sheep is fairly constant, the figures for 1911 being 30,479,807,* and it is computed that out of that number we slaughter about 40 per cent. every year. We are therefore able to compute the home supply of mutton and lamb at 326,570 tons, as compared with a total import of 268,149 tons. In carrying on this business in overseas countries, there are fifty-seven freezing works in Australasia, and eleven establishments of a similar character in South America, and their total produce, with a very slight deduction, which is sent to other countries, is shipped to the United Kingdom, there being some 205 cold storage steamers engaged in this trade,† and while the imported produce for 1911 was somewhat smaller than in the former year of 1910, there is every reason to believe that the imports in the future will be larger still, owing to the fact that the ratio of sheep produced in the United Kingdom to the population is constantly on the decline, and the demand for mutton is constantly on the increase. In 1871 the total of the flocks in the United Kingdom exceeded the population by 4 per cent. In 1881 there were 827 sheep to every thousand inhabitants, and in 1910 the number had fallen to 659 per thousand.‡

Mutton.

Mutton is derived mostly from young sheep of either sex. Much attention has been paid of late years to the characteristics which the carcass should present, and breeders have endeavoured to produce carcasses which will primarily have a small proportion of bone to flesh, and with a small amount of fat.

In judging a carcass, it may be said that the process should be, first of all, to divide it transversely through the middle, so as to expose what is known as the "eye" of the chop, and the principal features to be noted will be the colour, then the thickness of the lean, after that the firmness of the fat. In so far as the legs of mutton are concerned, these should be plump, and form an almost straight line from thigh to thigh. V-shaped legs are of an inferior quality, and will most likely present other features of bad breeding.* As a matter of fact, the question of judging the quality of mutton has been only within recent years reduced to something like a system, and a standard has been set up which appears to meet the requirements of the case.†

Standard of Excellence for Judging Carcasses of Mutton and Lambs.

1. Dressing of carcass	10
2. Colour, general appearance of carcasses, and firmness of flesh	10
3. Proportion of meat to bone	15
On splitting the carcass and dividing it transversely, the following points are to be noted:—	
4. Colour, texture, and thickness	10
5. Plumpness of legs of mutton	20
6. "Eye" of the chops and thickness of loin .	25
7. Fleshiness of forequarters	10
Total	100

It may be mentioned that the age of slaughter for sheep varies from two to three months to two years, but a ripe animal may be put down as being twelve months old. The weight of the carcasses varies from 45 to 100 lbs., the average of imported carcasses being about 56 lbs., and it is a remarkable feature of mutton that, if hung for some little time in a fresh cool atmosphere, it becomes much more palatable and tender.

"The process of mutton making," says one writer on the subject,‡ "is thoroughly English. The internal formation of fat is the first process in all the English sheep. A network of fat is first formed which envelops the intestines, and another mass accumulates on the kidneys. Thus it begins to be deposited on the rump, and the first symptoms are the sides of the rump rising, so that the backbone cannot be felt. They begin to be cloven. This progresses gradually on the back until the backbone is lost, and instead of the protuberant bones there is a crevice along the line of the back to the shoulder, or possibly to the juncture of the neck. Then it begins to

* Agricultural Returns.

† W. Weddel & Co.'s "Annual Review for 1911."

‡ Agricultural Statistics, 1910.

* *Scotsman*, December 11th, 1908.

† "The Meat Industry and Meat Inspection," by Gerald R. Leighton and Loudon M. Douglas, Vol. II.

‡ "Sheep and Shepherding," by M. M. Milburn.

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be accumulated on the sides, and proceeds towards the flanks, and forms on the breasts, shoulders, and brisket, thus showing how gradually the whole tendencies of the sheep in all climes are brought out to make a fat-mutton English, or rather British, sheep. When all this is accomplished, the sheep is fat or prime."

compared with 1,281,707 in 1911. A somewhat similar increase has taken place in New Zealand and South America, and these developments have become possible only through the use of mechanical cooling appliances. In fact, it is to the refrigerating machine that we are indebted for many accessions to the food supplies of this

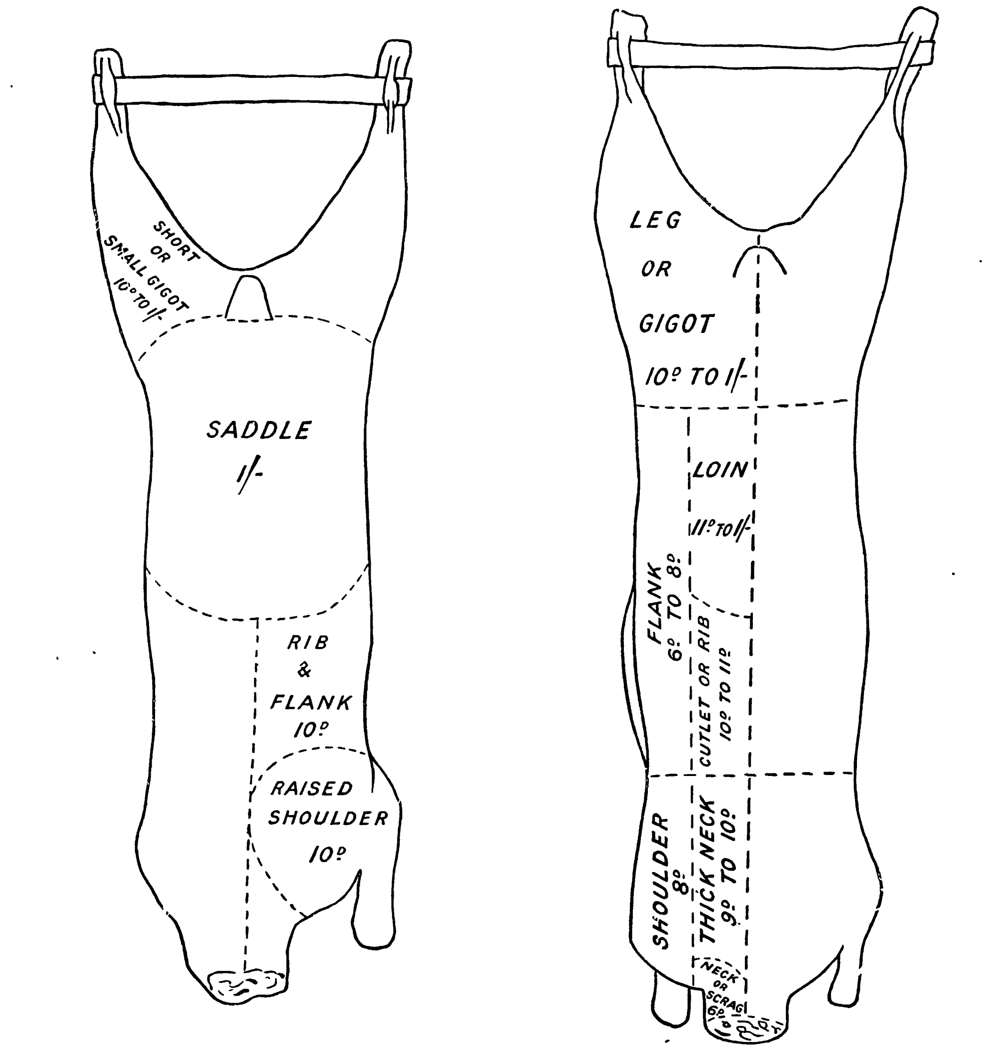

FIG. 9.—DIAGRAMS OF CARCASSES OF MUTTON.

Illustrating the various cuts and different methods of cutting up, as also the average prices in the United Kingdom.

THE FROZEN MUTTON INDUSTRY.

In discussing the question of the import of mutton from foreign countries, it will be desirable to recall that this trade has grown within comparatively recent times. It will be remembered that in the year 1880 the shipment of mutton carcasses from Australia numbered only 400, as

country. Its influence has, within the short time of a generation, annihilated distance and made it possible to have fresh food from the furthest colony delivered anywhere within the United Kingdom. It was in 1879 that the first cold-air refrigerating machine was installed on a vessel called the "Strathleven," which brought

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the first cargo of frozen meat from Australia to London, and, as we have already seen, there are now 205 vessels engaged in this trade. The principle of refrigeration, as applied to the storing of mutton, is now well understood, and it would seem to be the general opinion that it is undesirable to bring mutton from a distant country except in the frozen condition, or at a temperature some 12° below freezing-point, which means, of course, that a certain amount of rupturing of the cells takes place owing to expansion, and a consequent loss of meat juices supervenes on the thawing out. If, therefore, the chilling at a temperature of about 28° F. could be adapted to the handling of mutton, it would be an immense advantage from the economic point of view. It would hardly be possible to enter into the details of this question here; suffice it to say that it is one which deserves the best attention of refrigerating experts in this country and in the overseas countries referred to.

By-Products.

Wool.—So far, we have dealt entirely with the meat industry point of view of the sheep, and we may now with advantage consider what are the other products available. Many of the 146 products derivable from a bullock are also obtainable from a sheep, such as blood, horns, fat, sausage casings, pharmaceutical preparations, sausages, bones, fertiliser, etc., but the principal product is the wool, which, as we have said, is considered in many countries to be the chief product. This is especially so in Australia, where the merino predominates over all other breeds because of its wool-producing characteristic.* With regard to the Argentina, there has been a considerable modification in the breeds, owing to the introduction of the Lincoln type about 1845, which has been followed in later years by Leicesters and Romney Marsh types. Wool, however, is the main product to the sheep farmer of the Argentine, and it is curious to read that, so recently as 1843, the carcasses of sheep were boiled down entire and converted into fat, bones, and glue. As we have seen, that condition of things has been altered since 1883, and a steadily increasing exporting mutton trade is the result. Wool is one of the products which has become a necessity amongst civilised nations, and the fabrics which are made from it, so as to minister to our personal comfort, æsthetic tastes, or luxury, are much too numerous to mention. The wool-combing industry of this country is a gigantic one, and gives employment to many thousands of people, and this is not to be wondered at when it is considered that our imports of wool amount to 795,091,310 lbs., of a total value of £33,001,622, and some of our principal cities have been built up in consequence of their textile industries depending on the supply of wool. Much literature has been produced on the subject of woollen textiles, and the machinery which has been called into existence since the invention of Cartwright's wool-comber in 1801.*

Apart from the wool itself, there are other products which are derived from it also. There is a yolk or oily secretion which spreads from the skin to the wool of the sheep, and which is described as a soap with a base of potash. Many uses have been found for this particular by-product, not the least of which is the use of the oily extract as an emollient. The yield of the potash varies from 70 to 90 lbs. of pure carbonate, together with 5 to 6 lbs. of sulphur and chloride of potassium, from every thousand pounds of raw wool. Another substance, called "cholesterin," is also obtained from the wool, but no use has so far been found for it.

Sheepskins.—Next in importance to the wool of the sheep is the sheepskin itself, which is used for a great variety of purposes. When the pelts are split, very thin leather is produced, which is prepared as imitation chamois, or is used for glove making, the leather itself being utilised for a great many different purposes, such as book-binding, furniture making, and so on.

Blood.—The utilisation of the blood of the sheep is somewhat similar to that of the blood derived from bullocks. This serum, however, is used in Ireland for the production of a particular kind of sausage called "Drosheen," which I have not found in any other country.

Mutton Hams and Sausages.—In many parts of Scotland especially it is common to treat the leg of the sheep in the same way as an ordinary pork ham and cure it, and this product is worthy of being much wider known, as are also the mutton sausages which find so much favour in the Midlands of England.

Fat.—The fat of the sheep is of a peculiar character. It is generally white in colour, and very much harder than beef fat, owing to the large percentage of stearine which is present. From this cause it has also a high melting-point —namely, varying from 31° to 52° C. Mutton

* "Journal of the Department of Agriculture of Victoria, Australia," Vol. V. part x.

* "The History of Wool and Wool-Combing," by James Burnley, 1889.

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fat is very largely used for the covering of meat paste preparations, as it gives a hard cake on the surface. It is also used as an admixture in lard compound, as a substitute for the beef stearine which is generally present to the extent of about 20 per cent. in such preparations, and, owing to the fact that the fat itself is quite odourless, it is preferred above any other for these special purposes.

Violin Strings.—The intestines of small sheep are used for the manufacture of violin strings. They are simply spun like ordinary cord to different thicknesses according to the pitch required. The preparation of these violin strings involves considerable skill, and many establishments in this country and in foreign countries are devoted to this industry alone. Residual intestines, which may not be used for the finer violin strings, are generally spun into larger cords and used for the making of belts for transmitting the power in sewing-machines or even larger machines.

Milk.—Many of the races of sheep are used for milking purposes, and, notably in Holland, the sheep is extensively utilised for this purpose. At one time sheep-milking used to be very common in Scotland, ewe-milk cheese being prepared from the milk; but this custom has fallen into disuse. In France, however, the Larsac race of sheep is very extensively cultivated for its milk, from which the Roquefort cheese is prepared, and of which some ten million pounds' weight are exported from France annually. In the eastern parts of Europe, notably Servia, Bulgaria, and Hungary, the cultivation of sheep for their milk is quite a common practice, and great herds are collected together during the period of lactation, and the milk is mostly converted into cheeses of different kinds.

Sheep husbandry is, therefore, one of the principal pursuits of agriculture, inasmuch as the sheep provides so many of the comforts and necessities of civilisation. It is doubtful if any domesticated animal is more generally utilised throughout the world than the sheep, owing to the fact that it provides necessary food and clothing, with many luxuries as well. Although the bullock may figure in animal industry as producing the greatest number of products, it may be said that the sheep is capable of supplying all our wants in the shape of flesh, food, and clothing, but this could not be said of the bullock.

The utilisation of the residual by-products of the sheep in the United Kingdom is not studied at all from the scientific point of view, this being largely due to the fact that the quantities handled in any one place are not very large. It would seem reasonable, however, to suppose that, seeing that we have such large flocks and herds, it might be possible to aggregate the supplies of animals for slaughter in central slaughtering establishments, where the very best use could be made of all the residual products. As in the case of the bullock, this is entirely a question of education, and until a system of education is instituted from the point of view of the cultivation of animal industries, there is not much likelihood of any alteration in the present customs.

FOREIGN COMMERCIAL COURSES.

The International Society for the Promotion of Commercial Education has recently issued the full programme of lectures and other arrangements for the sixth meeting of the Society, which takes place this summer at Antwerp. Last year the meeting was held in London, at the School of Economics and Political Science, and some of the lectures were given in the meeting-room of this Society. Previous commercial courses were held at Lausanne (1907), Mannheim (1908), Havre (1909), and Vienna (1910).

The holiday course this year at Antwerp will be held from July 22nd to August 10th at the Institut Supérieur de Commerce, 41, rue des Peintres—probably the oldest, and certainly one of the best known, of the commercial colleges of Europe. The lectures, which will be given in French by leading professors and business men of Belgium, are grouped in three series:—

1. The economic development of Belgium.
2. The Belgian Congo.
3. Belgian art and monuments.

They will be given in the morning, commencing at 9 a.m., and also in the evening, thus leaving the afternoon free for the various excursions and visits to industrial undertakings which have already been arranged. The meeting is being supported by a large and influential committee of patronage, while the chairman of the executive committee, to whom the fee of 75 francs should be paid, is M. Ernest Dubois, Director of the Institut Supérieur de Commerce.

No country is better worthy of study from a commercial and industrial point of view than is thickly-populated Belgium, and young business men whose knowledge of the French language is sufficient to allow them to follow the lectures, would be well advised to make arrangements to attend the Antwerp meeting.

These courses of lectures provide an opportunity of acquiring a great deal of useful information about the business methods of our Continental trade rivals, and to a young man well started on a commercial career such an experience cannot be

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other than helpful and suggestive. The lectures are really business talks by men who have been selected for their practical knowledge of the special branches of commerce with which they deal.

By no means the least useful object of the meeting is the opportunity it provides for rubbing shoulders with students of many nationalities; by means of a language common to all the student is able to compare the institutions of his own country with those of other countries of the world. It would be difficult to overestimate the advantages of such discussions, for they cannot but enlarge a man's outlook on life in general, and give him a breadth of view which could otherwise be acquired only by extensive travel.

It is, however, a matter for regret that very few Englishmen have, up to the present, attended the meetings arranged by the International Society. When one notes the avidity with which the young Swiss or German acquires, and stores up, information gathered at such lectures as these, one cannot help feeling that by not availing themselves of such opportunities of obtaining useful business knowledge our countrymen are losing a very great deal.

Mr. Cleveland-Stevens, the Secretary of the Commercial Course held last year in London, writes as follows in summing up the results of that meeting*:—"Here were two hundred foreign students—there were but half a dozen Englishmen among them—mostly teachers or pupils at the Continental commercial academies, institutes, etc., who willingly sacrificed their short vacation to go through this exceptionally strenuous course. Moreover, many of them do it year after year; those who have been to one of these meetings seldom fail to come regularly in subsequent years to the succeeding meetings. Without entering into any discussion upon systems of commercial education, one may ask whether such a movement as this should not commend itself to all students of business and industry. Can we not find young men in this country whom we may profitably send to the meeting and lectures at Antwerp next year?"

It is certainly a strange fact that in a great commercial country like this, the importance of a sound, practical knowledge of foreign languages seems never to have been properly appreciated. It is probably true that owing to the almost universal use of the English language, and to the fact that it is the medium of international intercourse in the East, the necessity for speaking other tongues is not brought home to the insular Briton to quite the same extent as it is to a Continental business man. There must, however, be some reason other than this for the indifference which has hitherto prevented any real, live interest being taken in the teaching and study of French and German in this country. This indifference is no doubt largely a heritage of the past caused by the fact that the requirements of the older universities formerly demanded of the great public schools an entirely classical curriculum, in which there was little room for modern languages. It is true that secondary day schools have, from the first, devoted much attention to the study of French and German, but these languages were, more often than not, taught by foreign professors who, on account of their faulty pronunciation of English and their lack of knowledge of the character of the English schoolboy, exercised little influence over their pupils, and were seldom able to maintain proper discipline.

This is now, to a great extent, a thing of the past; the universities are, at the present time, fully alive to the importance of a proper study of foreign languages and literatures, although it must be admitted that the number of open scholarships for modern languages is still very limited. The public schools, too, now usually select their modern language masters from Englishmen who have studied abroad, and in so doing are following a system which Germany adopted many years ago. There are still, however, not a few secondary schools, and even higher institutions, where the teaching of modern languages is hopelessly out of date. Very often the classes are too large to permit of efficient instruction, in other instances the pupils have very little opportunity of hearing or practising the foreign tongue because they are kept far too long to the dry routine of grammar, while the more advanced students are often unfairly handicapped by the presence in the same class of others who do not understand the spoken language.

The accumulated indifference to the value of a knowledge of foreign languages shown by all classes in this country for many years past has resulted in an apathy and a lack of enthusiasm which goes a long way to account for the sparse attendance of Englishmen at these foreign commercial courses. This indifference is noticeable at the ordinary holiday courses arranged each summer in various Continental countries.* These meetings are naturally attended by many English people of either sex, but these latter are, almost without exception, engaged in the teaching profession, and are practically obliged to spend part of their holidays abroad in order to maintain the standard of their French or German pronunciation. It goes without saying that some are keen students who regularly follow the lectures and make the most of their opportunities, but on the other hand there are many who have no heart in their work, and, in great contrast to students of other nationalities, look on the whole thing as a bore. It is certainly the rarest event to find an Englishman attending the course for the more or less disinterested motive of acquiring French or German merely for his own satisfaction, or for the sake of the culture which is derived from the study of a foreign language and literature.

That young English teachers are not eager to

* *Journal*, Vol. LIX. p. 930.

* "Table of Foreign Holiday Courses." Wyman & Sons. 2*d*.

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avail themselves of a favourable opportunity for study abroad may be inferred from the fact that they do not take full advantage of the scheme, initiated by the Board of Education three years ago, for the exchange of teachers of modern languages between England, France, and Prussia. The number of English teachers placed in foreign schools as "assistants" in 1910-11 was fifty, but for the current year it has fallen to forty-two, of whom twenty-five are women. The last report of the Board of Education states that "the number of properly qualified male candidates for appointment in France is considerably below the number of available vacancies; and at the time of the preparation of this report (March, 1912), there were some ten posts in secondary schools in France for which the Office of Special Inquiries and Reports had been unable to find suitable candidates."

The teaching of foreign languages in this country has certainly improved during the past few years, and as some evidence of this improvement in London it is worthy of note that since the institution, ten years ago, of the viva voce examinations in foreign languages of the Royal Society of Arts, over 4,000 candidates have been awarded certificates. A fairly high standard is maintained, and the examination provides a good test of a candidate's ability to speak and write the language.

In London the County Council education authorities deserve much credit for the part they have taken in bringing about this improvement, and the teaching of foreign languages in their evening continuation schools is highly efficient. The Polytechnic in Regent Street has also, by means of an excellent series of lectures in French and German, done much to foster the study of these foreign literatures, but the lectures are, unfortunately, not attended by as large a public as their importance demands.

But, notwithstanding this more satisfactory state of things, one cannot but agree with the President of the Board of Education when he stated, only the other day in the House of Commons, that in the teaching of modern languages we are a long way behind our Continental competitors. One always expects a young German business man to have a good knowledge of English and French, and it is not easy to find one who has not; on the other hand when a German meets an Englishman speaking two or three languages he opens his eyes in astonishment, so exceptional is the circumstance.

Pupils in most secondary day schools devote a large proportion of their school hours to the study of French and German, and on leaving school at the ages of sixteen or seventeen have a fairly sound knowledge of the grammar, and can also read an easy book in those languages. A small proportion of these boys are able to consolidate their knowledge by a short residence abroad; the majority, however, being under no compulsion, and having no immediate incentive to continue their studies in this direction, rapidly lose whatever knowledge of the languages they may have acquired during many years of school life. French and German are not, of course, taught in schools entirely for the utilitarian purpose of enabling boys to speak these languages. The mental discipline and training of memory which the study of foreign languages encourages are also of great importance, and some authorities contend that their value from this point of view is as great as that of the classics. It does, however, seem very purposeless for a boy to spend so much of his school life in learning modern languages, a knowledge of which is bound, at some time or other, to be of practical use to him, only to give up his studies the day he leaves school. Surely some pressure should be brought to bear on these young men, either by parents or employers, to induce them to keep up their knowledge of modern languages. The time when a youth leaves school is just the moment when he has the best opportunities for continuing his studies in French and German; in fact he has, for the first time in his life, the chance of specialising. He has no longer the rather heavy burden of home-lessons which a somewhat crowded school curriculum demands, and in most cases he has the necessary leisure, more especially in the winter months, to attend some of the lectures and classes which are now brought to the doors of all.

The value of a short residence abroad for the purpose of learning a language is, of course, obvious. It may not be generally known that the Société d'Echange International des Enfants et des Jeunes Gens of Paris has built up an effective organisation for bringing into touch families in various countries who wish for a mutual exchange of their young people for the holidays, or for a longer period if necessary. It should prove an interesting experience to a schoolboy to spend his holidays occasionally in a foreign family, and a visit to France or Germany, paid at a fairly early period of school life, would undoubtedly quicken the interest he takes in these languages. To a youth preparing for an open competitive examination at the age of eighteen or nineteen, the spending of his school holidays abroad in order to practise the language, represents a valuable economy of time which should give him some advantage over his competitors.

It may, of course, be argued that English methods of commercial training are different from those of Continental countries, and it would be a mistake to condemn too readily our own methods. It is probably true, for instance, that our system, or want of system, provides a better opening for the man of initiative; it is, however, no use disguising the fact that the foreigner has come to look on our business methods as rather conservative, and it is partly for this reason that fewer young foreigners now enter London firms—except, perhaps, financial houses—as "volunteers" or unsalaried assistants than was the case ten or fifteen years ago.

During the last few years schools of commerce of almost university rank have been established in the big towns of the Continent, and it is the custom now for many young foreigners—the merchants of the future—to attend a course at one of these

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institutions, afterwards coming to England for a few months merely to improve their pronunciation of the English language which they have studied to such advantage in the commercial high school. The more enterprising young foreigner who wants practical business experience goes very often to the United States rather than to England.

It is, of course, common knowledge that the commerce of Germany has increased by leaps and bounds during the past few years. Anyone to-day revisiting one of the great commercial centres of that country after a lapse of, say, ten or a dozen years, cannot fail to be struck not only by the increased size of the town, with its new and magnificent public buildings and business premises, but still more by the well-dressed appearance and air of prosperity presented by its inhabitants of the middle-class, a prosperity which is largely consequent upon the improved financial position of officials and employees of commercial houses and industrial concerns.

Just how much a superior system of commercial and technical education has had to do with this success it would not be easy to say; that the young German devotes more time than his British *confrère* to preparing himself seriously for a commercial career there can be no doubt, and it would be hard to deny that this has done much to bring about German commercial success and has been the means of diverting much trade into German channels. In this connection it is not unworthy of notice that in the commercial world of London young merchants of foreign extraction, men perhaps whose fathers have become naturalised Englishmen, are usually successful in trade largely because their knowledge of foreign languages has enabled them to get a better insight into the details of their business.

In the strenuous commercial rivalry of to-day, and still more of the future, success will come only to those who have exhausted every means of studying the different phases of the special branch of commerce in which they are working. The most profitable sources of study must surely be the business methods and procedure of foreign competing firms, and the man who is able to devote his vacation during three or four consecutive years to attending the courses arranged in various countries by the International Society would lay in a store of knowledge which would prove to be of inestimable value to him in the future.

C. D. C.

THE WORLD'S PRODUCTION OF MANGANESE.

Manganese is obtained commercially from manganese ores, manganiferous iron and silver ores, and manganiferous residuum from zinc roasting. Manganese ores are found in many parts of the United States, but only at a few places do they occur in sufficient quantity to be of high commercial value. They have been mined in the New England, Appalachian and Piedmont regions in the eastern United States, in northern Arkansas, and to a small extent in central western California. Large quantities of manganese ore have been mined in New Brunswick and Nova Scotia, and small amounts in Quebec and Ontario. In Newfoundland, manganese carbonate of brownish colour occurs. There are manganese deposits of importance in the Province of Santiago de Cuba. A bed of manganese ore of superior quality is reported from the island of St. Martin in the West Indies, and another deposit has recently been discovered in Hayti. Manganese ore has not been mined to any extent in Mexico. The ores are widely distributed in Brazil; large deposits occur in the State of Minas Geraes, and smaller ones in the State of Bahia. Ores are also reported from the States of Matto Grosso, Parana, and Santa Catharina, and from the region of the Amazon River. In Chile the manganese deposits are all on the west slope of the Andes Mountains in the Provinces of Santiago, Coquembo and Atacana. As regards Europe, manganese occurs in Spain, in the Provinces of Huelva, Oviedo, Teruel, Ciudad Real and Murcia. There are eight or ten mines in the Province of Alemtejo, Portugal. The principal manganese mines of France are in the Departments of Saône-et-Loire and Ariège. Smaller deposits occur in the Departments of Indre, Aude, Hautes-Pyrénées and Lozère. Belgium does not produce manganese ores proper, but a considerable amount of manganiferous iron ores. The centre of production for these is the Province of Liège. They are also found elsewhere in Belgium. The chief occurrence of manganese in Germany is along the Rhine in the districts of Wiesbaden and Coblenz. Smaller deposits are found in the Harz Mountains, in the Bonn district and in Coburg Gotha. Manganese ores of three types occur in Sweden. Manganese ore is found in different parts of Austria-Hungary. In Italy the chief manganese deposits are on Monte Argentario at Carrara, at Rapolano, and on the island of Elba, at Turin, Pralorgnan and at Gambatesa. There are also small mines at Iglesias, on San Pietro Island, off the west coast of Sardinia. Manganiferous iron ore occurs in Tuscany, while in Greece it is found at Laurium. In both European and Asiatic Turkey, manganese ores are found, in the former in southern Macedonia. In the latter they are reported from Aptal in Trebizond, in northern Asia Minor near the Black Sea, and also from Flatza, in the same region. On the island of Cyprus, manganese ores occur at Strullos, near Larnaka. Russia has been for many years the leading producer of manganese in the world, the principal centres of production being in the Province of Kutais. Large deposits of manganese ore occur in Tunis, near Ain-Mulares. The quantity available is said to reach 1,000,000 tons. An important discovery of manganese has recently been made at Caledon, Cape Colony. The deposit is said to contain 30,000 tons of ore, with a manganese content of 42 per cent. Manganese ore

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is found in Madras and Bombay, in Bengal and in Lower Burma. Small deposits of manganese ore, containing 1·6 per cent. of cobalt, occur at Ampituja, Ceylon. Moderate quantities of manganese oxide are mined in Japan. Maganese deposits are found in the Philippine Islands, in Java, and in British North Borneo. Manganese ores are found in New Zealand, and in Australia, particularly in New South Wales, South Australia and Queensland. In the United Kingdom, the bulk of the manganese ore worked at present is in North Wales in the form of a bed of ferruginous manganese intercalated among the Ordovician (lower silurian) shales, near Aberdaron, in Carnarvonshire. Other beds are found in Merionethshire and in Ireland, in the district of Cork.

ARTS AND CRAFTS.

The South African War Memorial.—Writing and illumination have taken their place of late amongst the crafts that are largely taught and quite extensively practised. Indeed, hand-written and illuminated booklets are a feature of nearly all the Arts and Crafts exhibitions up and down the country. But, for all that, the illuminated record of the names of those who died in the South African War, which is to be preserved in Cape Town Cathedral, and was shown for awhile at the Victoria and Albert Museum, South Kensington, has probably come as somewhat of a revelation to a good many people. The public has become accustomed, it is true, to short poems, chapters from the Bible, the Communion Office, and other writings of inconsiderable length, carefully written and elaborately ornamented, but a folio volume of some 440 pages, written entirely by hand, and decorated on nearly every page with illuminated designs, is an undertaking which few would have expected to see carried through in the hurry and bustle of the twentieth century. That it has been successfully accomplished is matter for congratulation to all concerned in its production.

The planning, writing, and gilding of the book were entrusted to Mr. Graily Hewitt, and he has given us a volume which more than upholds his own reputation, and, by its character, freshness, and general excellence, justifies the claims of the pen to produce work with which the printing-press cannot in any real sense compete. Some hand-written pages make one sigh for a good piece of printing: the South African War Memorial proves beyond dispute that, in the hands of a really first-class scribe, penwork is a thing of beauty which, by virtue of its power of adapting itself to fill a given space, and the almost infinite variety which it exhibits, is peculiarly fitted to be used for a document of lasting and historic interest. Mr. Graily Hewitt has employed a version of a good Italian formal script of the fifteenth century for the body of the work, and has executed his headings in Roman capitals. It is, of course, in these last that he has had an opportunity, of which he has availed himself to the full, of showing how truly decorative good lettering in itself can be.

Mr. Allan F. Vigers's illuminations, whether comparatively simple or more elaborate, show throughout very competent workmanship. The titlepage and the heading of the index are wonderfully rich and intricate pieces of work, somewhat Oriental in feeling, but not quite like anything else ancient or modern, and very delicately treated; but there is a certain heaviness about the ornamentations of the majority of the pages which keeps them from being altogether satisfactory. It is not quite a pleasant surprise to find that heraldic badges and devices, which would have helped considerably to give interest and life to the decorations, have been altogether dispensed with. Mr. Vigers's scrollwork is vigorous and well-considered, and the plan of introducing into it flowers and animals, typifying the various regiments, is certainly to be commended, but these little additions are necessarily less striking than good heraldic ornament would have been. However, since the keynote of the decorations is peace, the book, perhaps, gains in consistency what it loses in interest by the omission of military symbolism.

The Silk Exhibition.—The Exhibition of British Silks held at Knightsbridge certainly merited all the attention it has received, for it showed that British manufacturers can and do produce brocades, damasks, and other silks of a quality and a beauty which public opinion in this country is inclined to imagine can only come from France. Perhaps the first thing which struck one at the exhibition was the beauty of the colour which greeted the visitor on every side. It is, of course, comparatively easy to get good colour with a surface so glossy as that of fine silk, but for all that, the colours to be seen at Prince's Skating Rink were, as a whole, wonderfully fine. They showed, moreover, to far better advantage than they might have done, because so many of the exhibitors had arranged their stands in tones of one or two colours, or had taken special pains and shown real taste in putting side by side shades which helped each other instead of clashing. One stand, which was rather forcibly attractive, was decorated entirely in blue and purple, while another was, as it were, papered with a shot silk, which took a different hue in the various lights which fell upon it.

When we turn to the design of the fabrics, the state of affairs seems to leave some room for improvement. There were good patterns in abundance, but for the most part they were copies or fairly close renderings of old French and Italian velvets and silks, or of the later English materials of the period of Dutch William and his successors. The modern designs as a whole were not very inspiring. One firm of manufacturers seemed so conscious of this fact that they had hung their damasks (probably from motives of economy, to save cutting), in such a way that, while in one width the pattern was the right way up, in the

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second it was standing on its head. It seems as though some of the leading British silk manufacturers have made up their minds that, as regards at least velvets, damasks, and furnishing silks in general, success is hardly to be attained through producing anything distinctively British, certainly not by offering the public anything new in the way of design. They apparently either do not want, or cannot get, modern designs for this class of material. Anyway, they go on reproducing good old patterns. There is something to be said for this procedure, of course; it is eminently safe, and within certain limits has excellent results, but it can hardly be called enterprising. William Morris was, undoubtedly, a head and shoulders above the ordinary trade designer, but Messrs. Morris & Co.'s stand at Knightsbridge bore witness to the fact that the best English design of his period, at any rate, could not only compete successfully with the old on its own ground, but has the added interest of a freshness and life which seldom survive in a pattern which has been copied and adapted over and over again, and has grown stereotyped by much use. Messrs. Warner & Sons, of Newgate Street, were, as was to be expected, by far the most important exhibitors, and their fabrics were to be seen not only on their own stands but (without mention of the makers' name) on those of the leading retail firms. Their exhibit covered a very wide field, including damasks, brocades, lampas, brocatelles, velvets and tissues wrought in gold and silver threads, as well as printed silks and thin materials for dresses, and was remarkable for its technical excellence. Some of the tissues into which metal was introduced were fine bits of workmanship as well as gorgeous pieces of colour, and the show as a whole would have more than held its own had it been compared with the striking exhibits of the French manufacturers which have been so important a feature of some of the more recent international exhibitions held on the Continent.

The stand of the Gainsborough Silk Weaving Company of Sudbury, Suffolk, was the most interesting of the smaller exhibits. The Genoa velvet in blue and brown on a neutral-coloured ground with skilful use of cut pile and terry; the mole-coloured velvet figure on a background of brocade, forming as it were a pattern on a pattern; the brocatelle with a ground made interesting by being tied down irregularly, and the clever copy in brocading of the effect of old embroidery were all worth looking at. Messrs. Burnet & Co., of Garrick Street, made a special feature of materials suitable for ecclesiastical purposes, and indicated that a much better effect can sometimes be obtained, when funds are limited, by the employment of a good woven fabric instead of poor embroidery. Their woven altar frontal, with its kneeling angels and central vine, would look far better in many a church than a piece of second or third-rate needlework.

Messrs. Pearsall and Co. showed a fine collection, or perhaps it would be better to say selection, of their well-known embroidery silks, and the flosses exhibited by the British Standard Dye Works, of Birkenhead, covered a range of colours for which workers sometimes seek in vain.

The Women's Guild of Arts and Crafts.—A certain number of the exhibitions devoted exclusively to women's work are not of such a character as to prove woman's superiority over, or even her equality with man in the field of Arts and Crafts. The little show held by the Women's Guild of Arts and Crafts at Lindsey Hall, Notting Hill Gate, however, if it could not be called very remarkable, did at least demonstrate what really capable, competent, and workmanlike work women are doing in the various branches of applied art. The guild includes many of the better-known women craft-workers as well as painters and sculptors, and they exhibited for the most part of their best. Amongst the most interesting pieces of needlework were two pieces by Mrs. Morris, of which the portière embroidered from her husband's design was a very striking piece of work. Miss May Morris exhibited a very dainty piece of boldly-executed embroidery on muslin, worked in exquisitely delicate colours, and Mrs. A. H. Christie's four d'oyleys were dainty and instructive pieces of workmanship, though her canvas-stitch embroidery serving as a kind of frame to a mirror, though beautifully executed, was far from pleasing both in colour and design. Mrs. Dawson's silver cup and cover with enamel decorations of gorgeously coloured nasturtiums on a deep blue ground showed how beautiful well-manipulated enamel colour can be, and Mrs. Gaskin's jewellery daintily shown on a background of mousy brown velveteen, was well designed and characterised by a sense of style. Miss Katharine Adams's bookcovers were noteworthy, as usual, on account of their tastefulness and restraint. Mrs. Stabler's little figures are always full of feeling, but they hardly seem to gain by being carried out in glazed earthenware. That may be due, however, to the quality of the material in which they are reproduced. They might quite possibly prove themselves admirably adapted to execution in pottery, if they were rendered in fine porcelain. Mrs. Bernard Jenkin's memorial panel of Florence Nightingale executed in a kind of mosaic of opaque glass paste is admirably adapted for its purpose. In short, the little exhibition more than justified itself by the high standard which was maintained by many of the exhibitors in the various crafts represented.

GENERAL NOTES.

Memorial Tablets.—A memorial tablet has been affixed by the London County Council to No. 32, Craven Street, Strand, the house in which Heinrich Heine lodged for about three months when he visited England in 1827. He was much impressed with London, describing it as "the

most remarkable phenomenon that the world has to show to the amazed mind of man." A tablet has also been placed on Devonshire Lodge, No. 28, Finchley Road, N.W., the home of Thomas Hood for the last two years of his life. This is the second tablet commemorating a residence of Hood's, another having been fixed by the Council in 1907 to No. 17, Elm Tree Road, N.W., the house in which the famous "Song of the Shirt" was written.

TELEPHONE SERVICE IN PRINCIPAL EUROPEAN CITIES.—*L'Illustration*, of Paris, gives the following statistics, showing the number of telephones in seventeen of the principal cities in Europe in 1911, and the ratio of inhabitants to each. From this it will be seen that whilst Stockholm possesses one instrument to every 4·7 inhabitants, neither London nor Paris are so well served, the ratio being 1 to 26·3 and 36·7 inhabitants respectively.

	Number of Instruments.	Number of Persons to each Instrument.
Stockholm	72,000	4·7
Copenhagen	45,000	11·4
Christiana	16,000	14·2
Stuttgart	16,000	15·5
Berlin	122,500	16·6
Berne	4,300	18·3
Munich	27,000	22·1
London	172,000	26·3
The Hague	8,000	36·1
Paris	75,400	36·7
Brussels	16,900	37·9
Budapest	18,600	39·4
Vienna	47,000	44·4
St. Petersburg	30,600	55·0
Rome	9,500	60·5
Lisbon	3,000	115·0
Madrid	3,500	155·0

THE UNITED STATES CEMENT PRODUCTION.—In 1910, according to a report recently issued by the United States Geological Survey, the production of Portland cement in that country amounted to 76,549,951 barrels, with a value of £14,376,000. This shows an increase over the 1909 output of 11,558,520 barrels, or nearly 18 per cent., and an advance in value of £3,200,000, or more than 29 per cent. This increase alone is greater than the total output of Portland cement in 1900. In addition to Portland cement there were also produced 1,139,239 barrels of natural cement, and 95,951 barrels of pozzuolanic cement, a total of 77,785,141 barrels.

CATTLE TRADE BETWEEN ARGENTINA AND ITALY. —A new and important trade in live cattle and frozen meat has been established of late between Argentina and Italy. During 1911, upwards of 34,000 head of cattle were landed at the port of Genoa, of which about one third were sent by rail to Switzerland. The remainder were forwarded chiefly to Rome and Milan. The quality of the meat was, generally speaking, satisfactory, although in some cases perhaps a little too fat to suit the Italian taste. About 10,000 tons of frozen meat was also landed at this port last year, but, in spite of its low price, public opinion is somewhat prejudiced against it.

INDUSTRIAL EDUCATION FOR NATIVES IN ERITREA.—The results obtained at the first examination ever held of the pupils of the industrial school at Chezen (Eritrea) are very encouraging. Established in 1909, on a very modest basis, by the (Italian) colonial government, this school has been attended, on the average, by seventy-five pupils (all Mussulman) whose parents appear fully to appreciate the advantage of a sound education for their children. The instruction is entirely gratuitous, and even as many as thirty pupils are boarded and clothed besides, free of charge. All the pupils are taught the Italian and Arab languages (spoken and written), the four rules of arithmetic, the Koran, as well as some elementary general knowledge. In addition to these subjects, pupils can learn telegraphy (the Morse system), typewriting, as well as the trades of the carpenter or blacksmith. It is hoped shortly to add the art of printing in Arabic characters.

NEW ZEALAND WINE PRODUCTION.—About one thousand acres in New Zealand are now under grape culture for wine. New Zealand grapes, which grow chiefly in the northern part of the North Island, produce good wine of the claret and Moselle type. An acre of grapes in the northern part of New Zealand can easily be made to yield five hundred to seven hundred gallons of wine annually. New Zealand cannot compete with hotter countries in producing full-bodied wine of high alcoholic percentage, and the local grapes do not have sufficient saccharine matter for ports, Burgundies, or sherries, without artificial assistance; but for light, popular wines, such as clarets and Moselles, climate and soil seem well suited. About seven years ago the New Zealand Agricultural Department established a viticultural experiment station in the North Island to demonstrate to intending vine-growers the most suitable varieties of American stocks on which to graft the best grapes, with information on the art of wine-making.

EXPERIMENTAL CULTIVATION IN LYBIA.—A proposal for establishing experimental gardens in various parts of Tripoli and Cyrenaica, now under Italian rule, is under consideration by the Ministers of War and of Agriculture. The *Bolletino dell Società Italiana di Agricoltura* states that the gardens, which would be cultivated by the garrison under the guidance of competent instructors, might render valuable assistance in testing the fertility of the soil and the suitability of each locality for growing different crops. The general direction would be entrusted to a professor well acquainted with tropical flora and cultivation.

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Journal of the Royal Society of Arts.

No. 3,113. VOL. LX.

FRIDAY, JULY 19, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE MEAT INDUSTRY.

By LOUDON M. DOUGLAS, F.R.S.E.,
Technical Adviser on Animal Industries.

Lecture III.—Delivered February 19th, 1912.

THE PIG AND ITS PRODUCTS.

Swine husbandry has long formed a leading feature in the economy of the farm, and from ancient times until the present day the pig has been cultivated very largely, because it is easily housed and fed—it acts, as it were, as a scavenger on the farm. For the same reason the rural householder often maintains one or more pigs, so as to utilise the food residues from the household.

This feature especially prevails in Ireland and in the northern part of England, but, otherwise, the pig is mostly associated with agriculture.

HISTORICAL.

Many ancient authors have dealt with the pig, and the student of early agricultural literature cannot fail to notice that in the schemes of agriculture as laid down by such authors as Thomas Tusser in the sixteenth century, Fitzherbert and Gervaise Markham in the seventeenth century, Edward Lisle at the beginning of the eighteenth century, John Mills in 1776, and Arthur Young at the beginning of the nineteenth century, it is recognised that British farming would not be complete without the cultivation of Swine Husbandry. At so early a date as 1705 we find Edward Lisle, who was a noted writer in his day, describing in his " Observations in Husbandry " how pigs were then fed in Wiltshire, and the business became so notable that from that day until now " Wiltshire Bacon " has been the description applied to meats that are dressed and cured in a certain way throughout the world. It is to Scotland, however, that we are indebted for the first treatise on the pig, from the point of view of the curing of bacon. A Scottish farmer, called Robert Henderson, wrote " A Treatise on the Breeding of Swine and the Curing of Bacon " in the year 1811, and he may be said to have placed the business of curing, for the first time, upon a methodical basis.

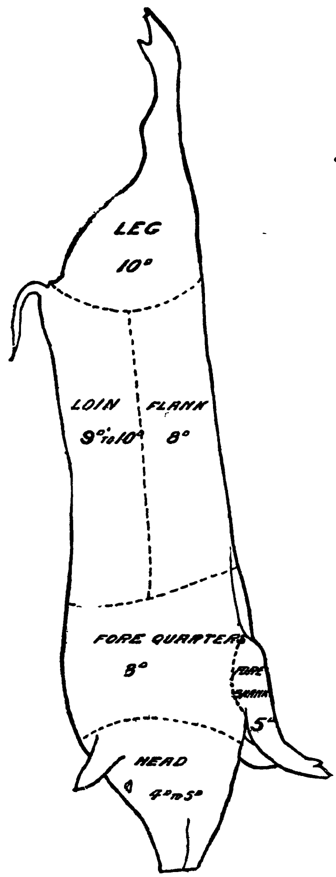

FIG. 10.—DIAGRAM OF A SIDE OF PORK.
Showing average prices for various cuts realised throughout the United Kingdom.

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The Breeds of Swine.

There are many different breeds of swine, every country having its own particular type. Generally speaking, the modern types of all countries take their origin from the British breeds, and this remark applies all over the world wherever swine are cultivated. There are, however, certain breeds which stand out pre-eminently above all the others in the United Kingdom at the present day, and these are six in number, namely:—

The Large White Yorkshire.
The Middle White Yorkshire.
The Large Black Sussex.
The Tamworth.
The Berkshire.
The Lincolnshire Curly Coated Pig.

In different countries there are other breeds, but they are not in sufficient numbers nor have they sufficiently pronounced characteristics to warrant any special classification, and there would seem to be a tendency to confine the British breeds to the six mentioned. In some countries where bacon-curing for the British markets has developed quickly, the British types of pigs have been crossed with the native breeds, and independent types have in this way been produced; but their leading characteristics and points of excellence are practically the same as in the British breeds.

Statistics.

In many countries the rise in the numbers of pigs has been very great, the tendency all over the world being towards rapid increase, which would seem to signify that there is a continuous and increasing demand for pig products. The number of pigs throughout the world may be stated at 142,272,275, which is the estimated figure inclusive of Europe, North and South America, Asia, Australia and Africa.* Out of the total number by far the largest figure belongs to the United States, there being in that country 59,288,592; † next in importance comes Germany with some 22 millions of pigs, the balance of the total being made up of smaller numbers, the United Kingdom contributing only a little over 4 millions, made up as follows:—

Pig Supply in the United Kingdom.

Great Britain, 1911	2,822,154
Ireland, 1910	1,200,005
	4,022,159

* "Statistique des Superficies Cultivées, de la Production Végétale et du Bétail," Institut International d'Agriculture, Rome, 1910.

† *Cincinnati Price Current*, January 4th, 1912.

This is rather strange, seeing that the British people are such lovers of pig products, and it has often been subject of comment that British farmers do not appear to appreciate the fact that there is a constant and ever-increasing demand for pig products in the United Kingdom.

The imports alone of bacon and the principal pig products are of a gigantic nature, and represent a value of nearly 20 million pounds sterling per annum.

In addition to these imports there are other pig products which represent vast sums of money, such, for example, as lard, which is imported to the value of £4,251,758,* and minor products, such as pigs' bristles, gelatine and margarine, a large proportion of which consists of lard derived from pigs. Besides these again, there are food preparations brought into this country in the tinned state and in glass moulds which are of immense value, but which cannot well be separated out from other preserved provisions. Sufficient, however, has been said to illustrate this particular point, namely, that a vast sum of money is being paid to other countries annually for pig products, a large portion of which at least could very well be retained in this country.

Swine Husbandry.

It must be understood that the breeds of swine which have been mentioned are not looked upon as being desirable in themselves for making the best pig products. The cross-bred pig is generally preferred, and is looked upon as being more profitable than the pure-bred animal, more especially for bacon-curing purposes, where the kind of pig that is wanted is one with a small proportion of bone to flesh, the live animal being of a somewhat rectangular shape and the fat of the carcass being firm to the touch, when at the normal temperature of the atmosphere. The head should be neat in shape, with a light neck and shoulder, and the side of the animal should be long, with a moderate depth. These features are so well understood amongst breeders that there is no difficulty in producing them from generation to generation, the scientific breeder knowing very well that this particular conformation will return the best price. It is also known that an animal weighing twelve stone dead weight, that is to say, with the primary offal removed, and being equal to about 15½ to 16 stones live weight, should arrive at maturity in from seven to eight months. It is within these few principles that successful pig-breeding lies.

* "Accounts Relating to Trade and Navigation of the United Kingdom."

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IMPORTS OF BACON, HAM AND PORK INTO THE UNITED KINGDOM.

Meat.		Quantities.			Values.		
		1909.	1910.	1911.	1909.	1910.	1911.
		cwts.	cwts.	cwts.	£	£	£
Bacon	From Denmark . .	1,809,745	1,794,416	2,122,087	5,801,382	6,341,726	6,690,937
	,, U.S.A. . . .	2,189,053	1,306,921	1,817,835	6,057,473	4,453,293	5,067,533
	,, Canada . .	443,386	411,935	615,807	1,364,357	1,449,637	1,793,946
	,, other countries	183,279	350,117	313,009	578,453	1,146,618	910,998
	Total	4,625,463	3,863,389	4,868,738	13,801,665	13,391,274	14,463,414
Hams	From U.S.A. . . .	1,073,569	665,775	887,303	2,952,084	2,329,626	2,712,287
	,, Canada . .	53,593	37,621	62,295	154,222	138,232	197,524
	,, other countries	1,867	15,730	5,213	6,590	58,837	17,799
	Total	1,129,029	719,126	954,811	3,112,896	2,526,695	2,927,610
Pork—salted (not bacon or hams)	From Denmark . .	197,594	179,888	186,477	193,501	190,529	186,439
	,, U.S.A. . . .	55,639	38,866	45,769	113,555	101,645	99,057
	,, other countries	5,306	8,437	4,503	5,806	11,994	7,667
	Total	258,539	227,191	236,749	312,862	304,168	293,163
Pork, fresh and refrigerated:—							
Fresh	From Netherlands .	378,376	366,197	370,345	905,741	900,116	940,068
	,, Belgium . .	10,215	8,848	14,537	25,359	24,006	41,645
	,, other countries	25,945	54,207	16,225	63,628	144,111	34,422
	Total	414,536	429,252	401,107	994,728	1,068,233	1,016,135
Chilled	From U.S.A. . . .	878	—	—	1,694	—	—
	,, other countries	—	—	—	—	—	—
	Total	878	—	—	1,694	—	—
Frozen	From U.S.A. . . .	6,377	1,044	4,099	14,200	2,880	9,324
	,, other countries	6,653	49,611	47,726	12,700	126,684	95,305
	Total	13,030	50,655	51,825	26,900	129,564	104,629
Total of Pork, fresh and refrigerated		428,444	479,907	452,932	1,023,322	1,197,797	1,120,764

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The feeding of the pig is the first consideration, and a balanced ration to suit local conditions is what every pig-breeder should try to arrive at. The food in different localities will necessarily vary, and in arriving at the ration it will be necessary to take into consideration what is the food value of the material available. As a comparative basis it may be said that an average well-balanced food will consist of: 1 gallon separated milk, 3 lbs. potatoes, and 4 lbs. barley meal per pig per day, the ration being divided up into three portions and given at regular intervals during the day. Such a ration will be equivalent, in fattening a pig of over 80 lbs. weight to begin with, to a gain of something like 15 lbs. weight per week. The whole question of breeding and feeding, however, is a very extensive one, and would warrant very much closer and more elaborate consideration than we can possibly give it here, where we can only indicate the general principles which must be recognised so as to command success.

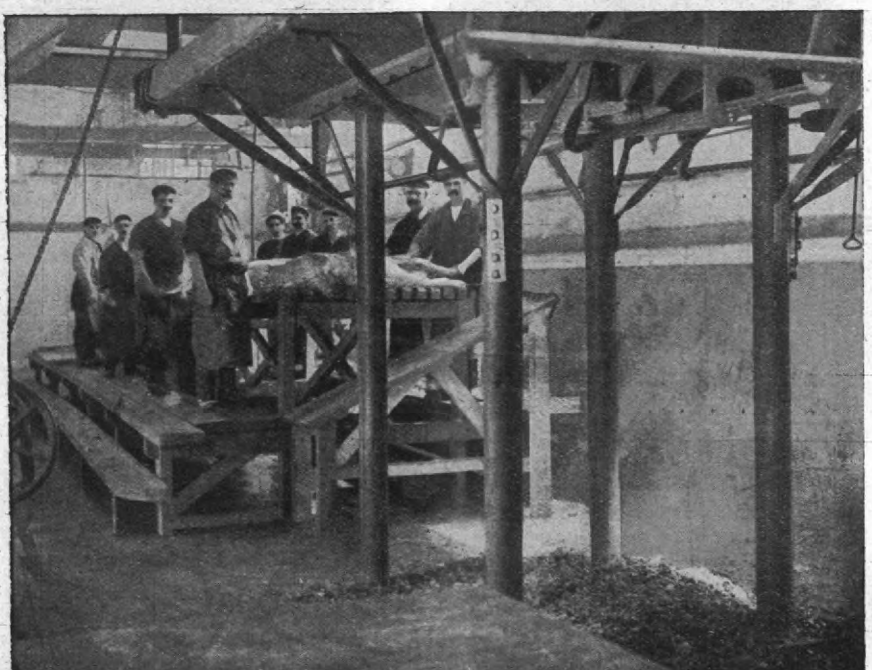

FIG. 11.—VIEW SHOWING SCUTTLING TABLE AND BASE OF SINGEING FURNACE.

THE HANDLING OF THE PIG.

So far, there has only been one attempt to arrive at the number of factories and the people employed in connection with bacon-curing and kindred industries in the United Kingdom, and these figures are very interesting.* They show that in bacon-curing factories in the United Kingdom we produce 1,716,000 cwts. of bacon and 457,000 cwts. of hams every year, and this reckons out to a total value of £7,023,000; but there are other products, such as salted pork, lard, sausages, pigs' heads, sausage casings made from intestines, preserved meats, such as brawn, tinned meats, etc., offals and residual products, all of which contribute to make up the total to £10,509,000 as the value of these products in the United Kingdom, and it would appear that 7,294 persons are employed in this particular industry. But these figures do not take account of the pork purveyors throughout the country, who number something like 10,000, and who must handle amongst them at least an equal quantity of pigs, which are converted into fresh pork and smaller products in their shops. It will be seen, therefore, that the industry of Swine Husbandry and the manufacture of pig products is a comparatively small one in the United Kingdom. The general deduction to be made from the figures given is, that the business is neglected in this country and that advantage is taken of our indifference in the matter by many foreign nations, who send their pig products to our markets.

PIG PRODUCTS.

Live Pigs.—When the pig is brought to the factory it is first of all weighed in the live

* "Census of Production—Preliminary Tables," Part VI., 1911.

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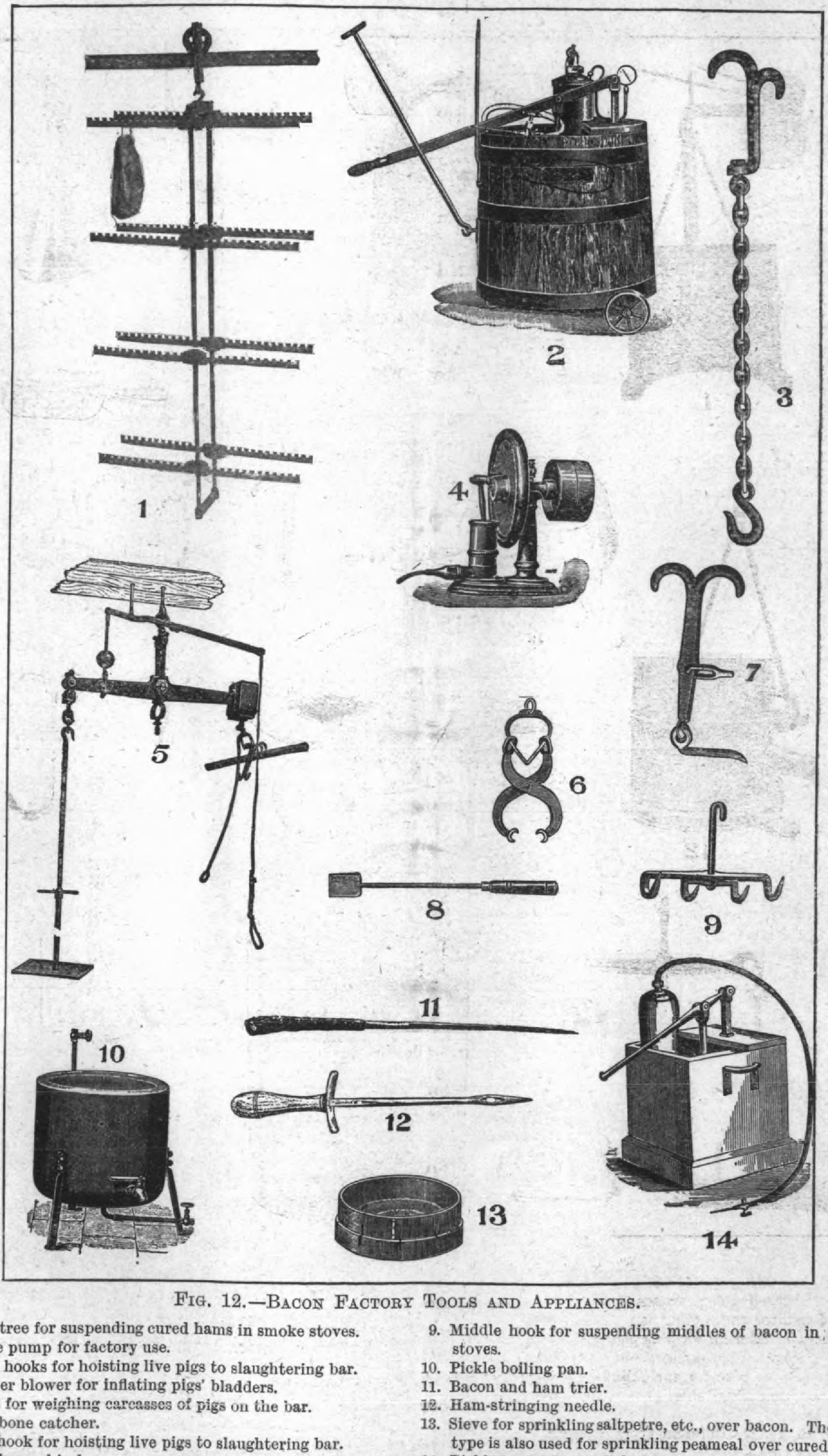

FIG. 12.—BACON FACTORY TOOLS AND APPLIANCES.

1. Ham tree for suspending cured hams in smoke stoves.
2. Pickle pump for factory use.
3. Chain hooks for hoisting live pigs to slaughtering bar.
4. Bladder blower for inflating pigs' bladders.
5. Scales for weighing carcasses of pigs on the bar.
6. Bladebone catcher.
7. Drop hook for hoisting live pigs to slaughtering bar.
8. Bladebone chisel.
9. Middle hook for suspending middles of bacon in smoke stoves.
10. Pickle boiling pan.
11. Bacon and ham trier.
12. Ham-stringing needle.
13. Sieve for sprinkling saltpetre, etc., over bacon. The same type is also used for sprinkling peameal over cured sides.
14. Pickle pump for small factory use.

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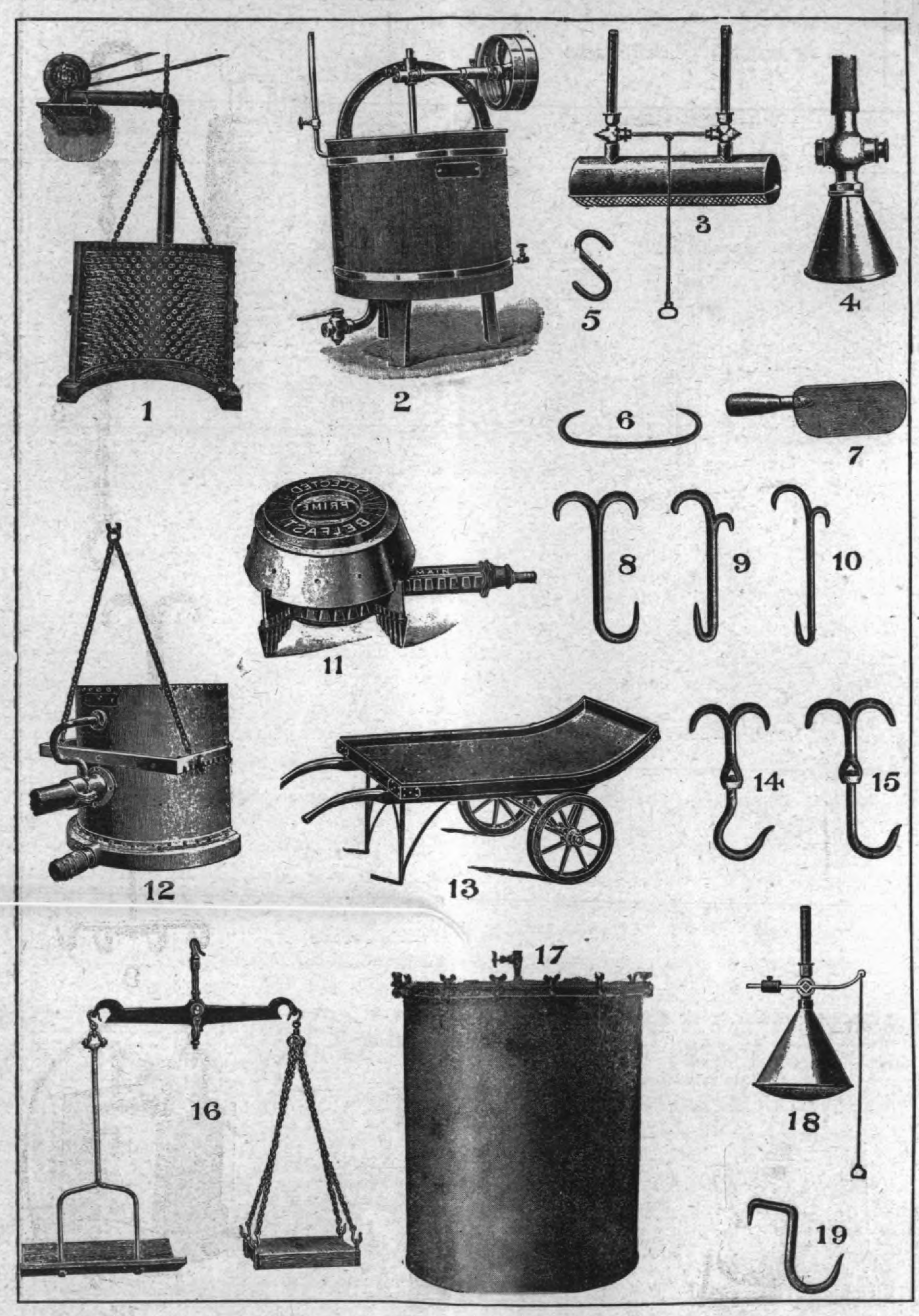

FIG. 13.—BACON FACTORY TOOLS AND APPLIANCES.

1. Saddle-back singeing furnace (inside view).
2. Lard agitator and cooling pan.
3. Water sprinkler for washing pigs' carcasses after they have been singed.
4. Thumb-valve rose for sprinkling water over carcasses of pigs on scuttling table.
5. S hook.
6, 8, 9, 10, 14, 15. Different types of hooks.
7. Flat pig scraper.
11. Ham and bacon brand for gas.
12. Saddle-back furnace (outside view).
13. Bacon truck for use in the factory in transporting cured sides from the bacon bed.
16. Bacon scale.
17. Mudgeon or rough fat boiler.
18. Water sprinkler for washing pigs after being singed.
19. Hanging hook for attaching to overhead beam.

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condition, and it is the custom to pay for the animal by live weight. In some districts pig breeders prefer to be paid by the dead weight, viz., the weight of the carcass, minus the primary offal, consisting of the hair, blood and viscera. The dead weight is represented by the carcass in this condition, but if the weighing takes place while the flesh is warm there is always a deduction made varying from 2 to 4 lbs. per carcass, according to local custom, as a set-off in case of loss incurred by the evaporation which takes place during the dissipation of animal heat. In British factories the live pig after being weighed is merely passed on to sties, where it is allowed to rest over a night if possible, so that all traces of excitement may have disappeared.

Bristles.—It is at this point that in Russia, Hungary, France, and one or two other countries, the bristles from the back of the pig are cut off by means of strong scissors, the bristles being collected by hand, and only those are taken which surmount the ridge of the back, as in that particular place they are strong. It will be obvious that these bristles can only be gathered where the breed of pigs possesses strong hair. The hair of British breeds being of a soft or silky character does not lend itself to this business at all. Those breeds of pigs, however, which have been derived from the wild boar exhibit this feature very strongly, and it is from them that the supplies of bristles are taken. It is a very substantial industry, as may be gathered from the fact that we imported last year (1911) 4,727,063 lbs., at a value of £709,180, the average price reckoning out at about 3*s.* 6*d.* per lb. These bristles are used for tooth-brush making, and have first of all to be selected and bleached. The business gives employment, in certain centres where it is specialised, to a large number of hands, as most of the work cannot be done except by hand labour.

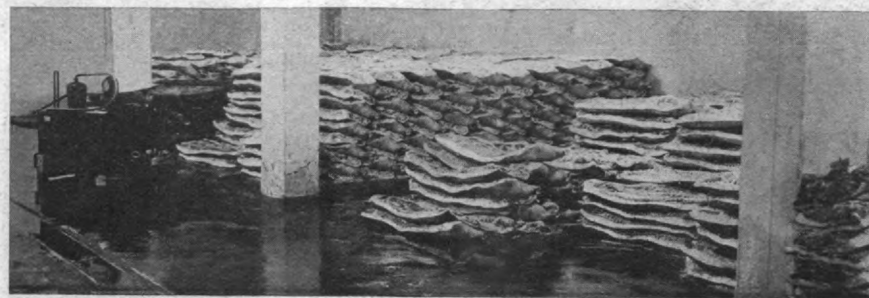

FIG. 14.—CURING CELLAR IN AN IRISH BACON FACTORY.

BACON CURING.

The principal use for the pig is the manufacture of bacon and hams, and the process of conversion into these commodities has now been reduced to a thoroughly scientific basis. At one time, not so long ago, the curing of bacon was looked upon as being a secret business, and the recipes were supposed to be handed on from one generation to another, but never written down. Happily, all that mystery has disappeared, and it is possible now to learn the whole of the process accurately from text-books which are available

FIG. 15.—HANGING HOUSE IN IRISH BACON FACTORY.

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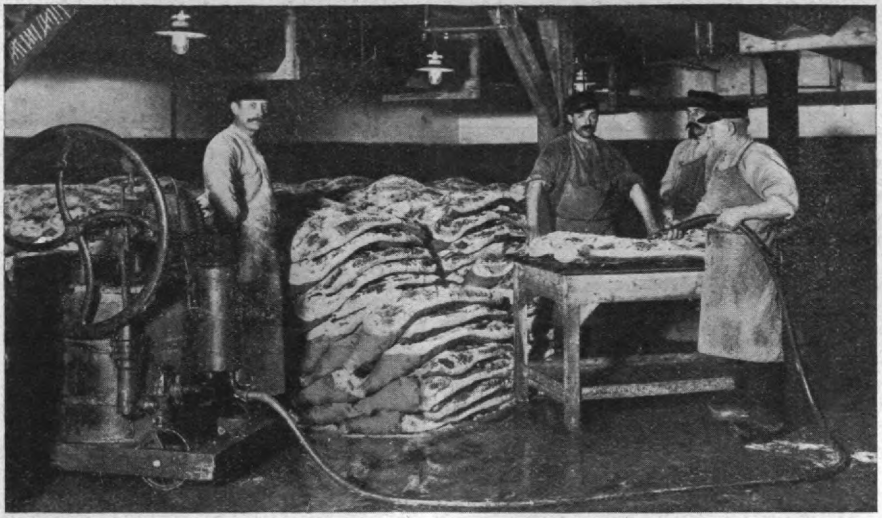

FIG. 16.—PUMPING BACON IN DENMARK.

In Denmark only Wiltshire sides of bacon are produced, and the bacon is all pumped before being placed in the curing bed and covered with salt and saltpetre.

on the subject.* A brief sketch of the process, however, will be of interest at this particular point.

The pigs are driven in to a catching-pen and are caught up, one by one, by a chain with a ring at the end of it, which is used to form a noose. The chain is slipped over one of the hind feet and the animal is hoisted head downwards to an overhead bar, and is there instantly slaughtered by the cutting of the main blood-vessels of the throat. I am inclined to think that although this is the universal practice, it would be more humane if the animals were first of all rendered unconscious, which could easily be accomplished by using a round-headed mallet. A sharp stroke from this weapon upon the front of the skull would produce temporary concussion and unconsciousness, and would in no wise interfere with the value of the carcass afterwards.

When the animals have been bled, the carcasses are pushed along on to a dumping table, where the shackling chains are removed, and they are then thrust into a tank containing water at a temperature of from 160° to 185° F., where they are scalded and the hair removed. After this they are passed on to a singeing furnace, which

* See Douglas's "Encyclopædia for Bacon Curers"; also "The Meat Industry and Meat Inspection," by G. R. Leighton and Loudon M. Douglas.

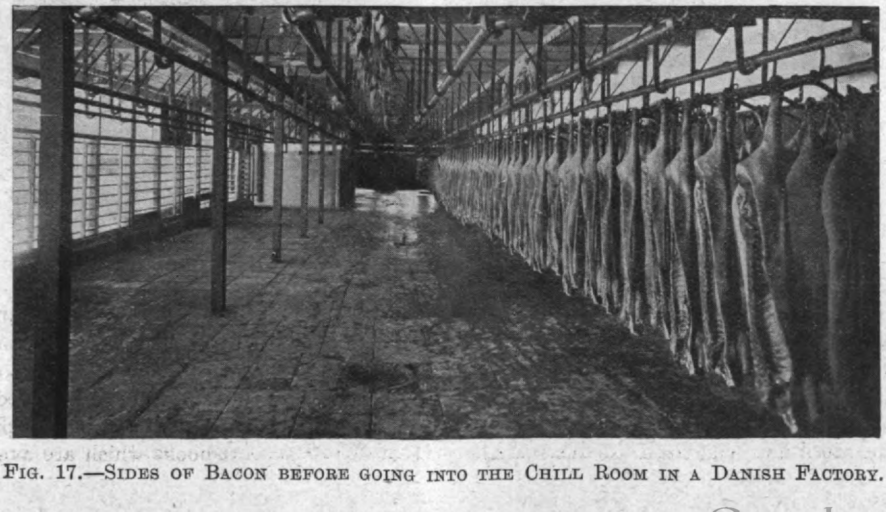

FIG. 17.—SIDES OF BACON BEFORE GOING INTO THE CHILL ROOM IN A DANISH FACTORY.

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is used to singe the carcasses where Wiltshire bacon is produced. This particular feature, namely, the singeing of the carcasses, produces a certain flavour in the meat and also serves to remove the remainder of the hairs which may be left. The subcutaneous fat, which might otherwise be soft in the cured material, is melted, and when the singed carcass is withdrawn after twenty-five seconds from the singeing furnace this fat immediately cools again and becomes hard. The singed carcasses are cooled as they emerge from the furnace in a bath of cold water, and are hung upon the dressing bars, where they are cleansed and disembowelled. Singed or unsinged carcasses from this point are treated in exactly the same way. They are first of all cleansed with cold water and scraped clean, the intestinal offal is removed and carried away to a department where it is handled by itself. The carcass, with the kidney fat remaining, is allowed to hang on the bar for some time in the dressed state, and it is at this point that it represents what is known as the "dead weight." The carcass is then split, the back-bone or vertebral column being removed; the secondary offal, consisting of the head, feet, and kidney fat, is all removed. The removal of the vertebral column liberates the two sides, which are allowed to hang until their temperature is somewhat adjacent to the atmospheric temperature, after which they are put in a chill room and cooled to about 38° F., by means of a current of cold dry air, which is set in circulation by a fan over pipes forming part of the circuit of a refrigerating machine. When these sides are reduced to 38° F. they are ready for curing, and are then transferred to the bacon-curing cellar, where the blade-bone is drawn out. The curing is then proceeded with, and it consists of pumping each side at a pressure of 40 lbs. to the square inch, with a pickle of recognised composition. The pumping is conducted by means of a pickle pump, to which a needle is attached, and this needle has a number of perforations arranged in a spiral manner through which the pickle is discharged, and in this way at once comes in contact with the tissues of the meat. When this has been done, the sides are laid one by one on the floor of the curing cellar, which is maintained at a temperature of 42° F., and the atmosphere must be humid and moist. The sides are covered over with an equal mixture of saltpetre and curing preservative, on the top of which is placed a heavy layer of salt. Under these conditions the curing proceeds, and the salt, as it melts, takes the place of the meat juices. At the end of about fourteen days the process is complete. The bacon may then be sold as mild-cured bacon, or it may be washed, dried and smoked, and sold as smoked bacon. It will not, however, keep very long in this mild-cured condition. Should it be necessary to keep the bacon for a long time, then it will have to remain in the salt for a proportionate period. Farm-cured bacon, as a rule, is kept in salt for

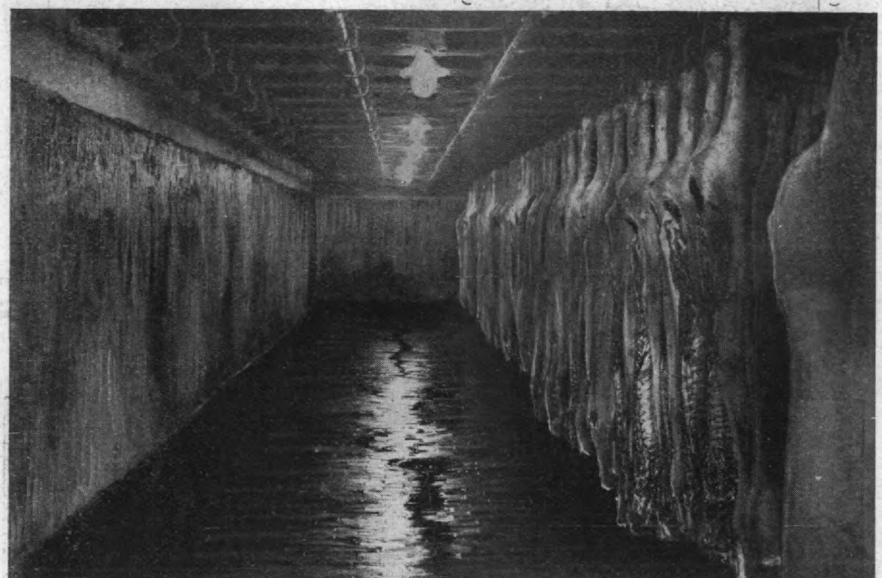

FIG. 18.—THE CHILL ROOM IN A DANISH BACON FACTORY.

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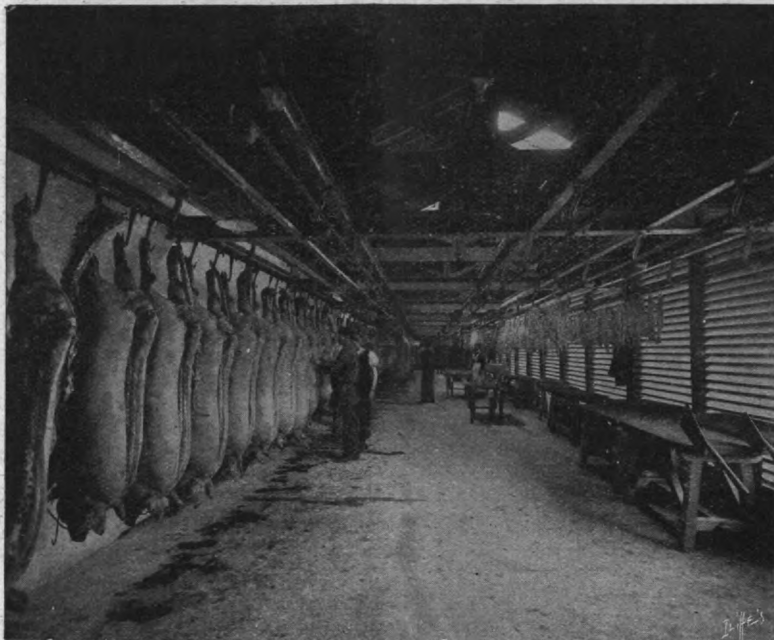

FIG. 19.—"SCORING" THE CARCASSES.
The first operation after the carcasses have been allowed to hang is the "scoring," which means taking out the backbone and severing the sides.

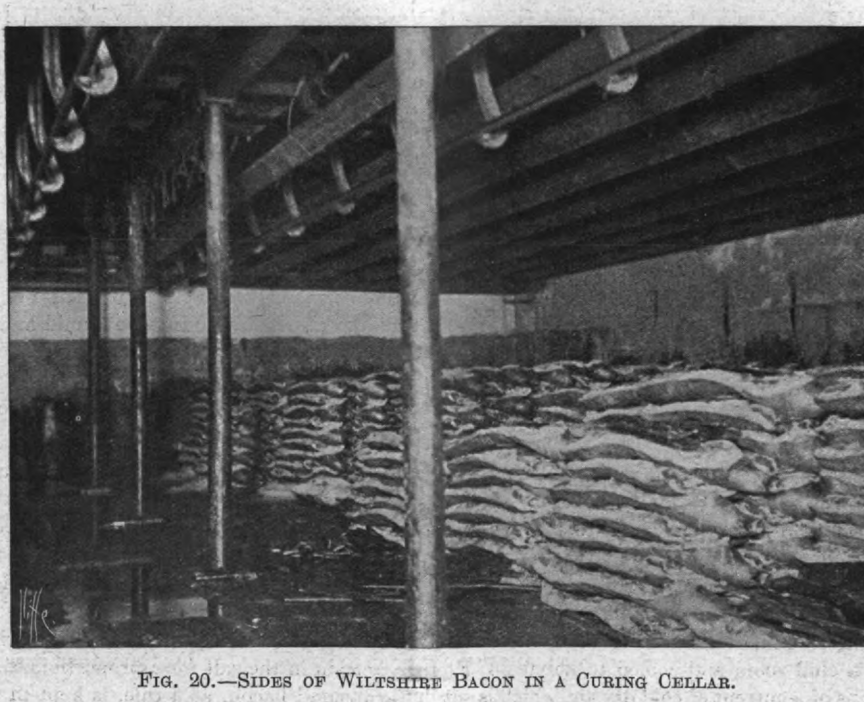

FIG. 20.—SIDES OF WILTSHIRE BACON IN A CURING CELLAR.
In the curing of Wiltshire bacon the sides are uniformly stacked as shown.

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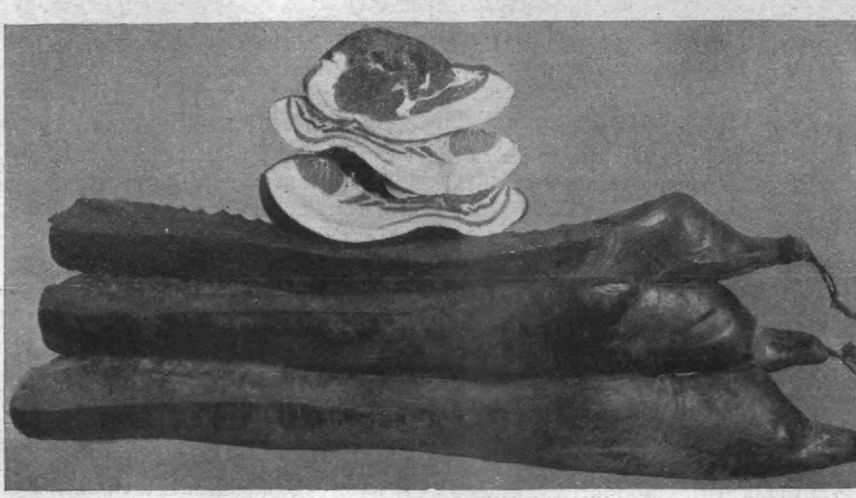
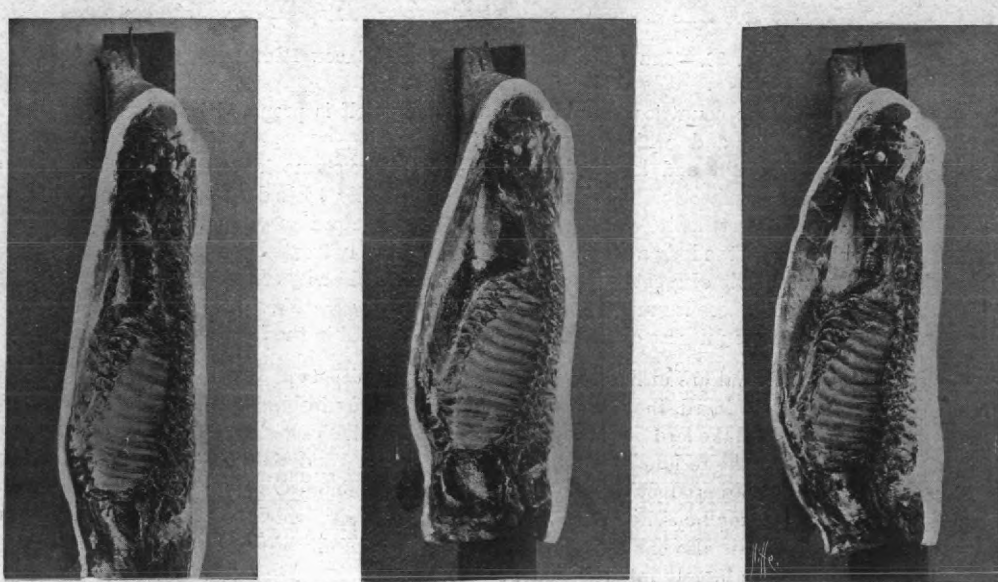


FIG. 21.—DEVONSHIRE SMOKED BACON (DAIRY-FED).

at least twenty-eight days, and generally is intended to be kept for many months afterwards.

The Curing Process.—The exact process which goes on in the production of bacon is not merely the displacement of the meat juices by a solution of salt and curing material. There is also a certain decomposition proceeding, due to the presence of micro-organisms which are always to be found where flesh of any kind exists. These putrefactive organisms assist in the curing process by breaking down some of the tissues of the meat, notwithstanding the presence of salt, which has no antiseptic effect on some of them. This is how the bacon flavour arises as distinguished from fresh or pickled pork. The flavour is largely due to decomposition.

Other Products.—Bacon and hams are cured in pretty much the same way, and there are many different forms in which these commodities are presented to the public eye, peculiar cuts and sections being popular in different neighbourhoods. These are mere details, however, and are not affected by the methods of curing which are practically identical throughout. There are, necessarily, the heads, feet and houghs to be dealt with, and these are generally immersed in pickle of a recognised density, and are cured to suit the public taste.



1. Lean Sizable. 2. Medium. 3. Fat.

FIG. 22.—TYPICAL SIDES OF DANISH BACON.

Blood.—One of the large by-products in a bacon factory is blood-puddings, which are simply composed of pigs' blood, some barley or groats, pieces of fat and flavouring herbs and spices. In some districts small factories exist where tons of these commodities are produced every week.

Pork Sausages.—Pork sausages are by far the most popular of the products in connection with bacon, and there are many factories which exist for the purpose of producing these as their main product. It has been computed that there are 5,000 tons of pork sausages produced in the United Kingdom every year.

Other Sausages.—Not only are there pork sausages, but there are a great many other kinds produced in the modern bacon factory, as there are also such commodities as galantines, brawns, pork pies and many other specialities. These may be included under the heading of *charcuterie*, which is a branch of industry that is very largely practised in some countries, notably in France and Germany, and which involves considerable technical skill and knowledge of cuisine. This is not the place to enter into the details of this wide subject, as it would lead us too far and would occupy too long a time.

Lard.—Lard is an article of great importance to the bacon-curer, and there is much expensive machinery devised for the purpose of converting rough lard into a marketable product. The different fats in the animal are utilised so as to produce different grades of lard, the best quality being obtained from the flake lard or kidney fat, rough grease, including the residual fats of the carcass, being the ultimate product.

Besides being of use for household and confectionery purposes, lard is also one of the bases of margarine, and enters largely into its composition. As we have seen, there is a great demand for lard in the United Kingdom, which is not satisfied by the home product. In 1911 we imported from the United States of America 1,719,292 cwts.; from other countries, 103,468 cwts., the total value being £4,251,758.*

It will thus be seen that we are compelled in this country, not only to import an immense quantity of bacon and hams, but we are also compelled to go overseas for a large portion of the fat required for domestic and confectionery purposes.

Other Pig Products.—A good deal of capital is represented in the utilisation of the intestinal offal of the pig. The casings or intestines are largely in demand for various kinds of sausage making. The bladder is utilised for the packing of lard. The stomach is the principal source of pepsin, which is used so largely in its various forms for the conversion of the proteids into soluble peptones. The process of elimination of the pepsin is a highly technical one, and the product itself is prepared in a great variety of forms.

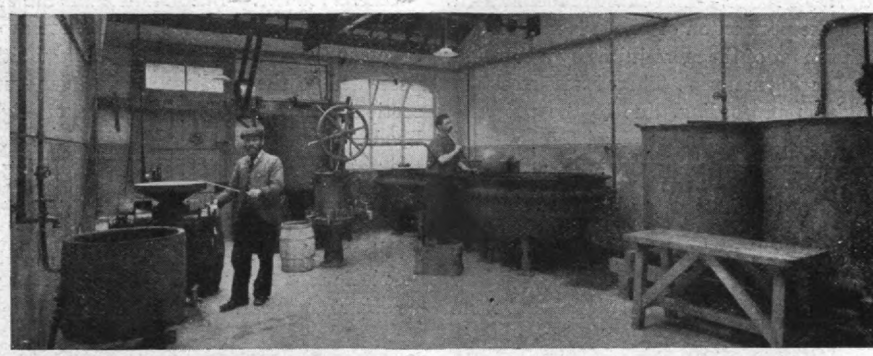


Fig. 23.—The Lard Room of an Irish Bacon Factory.

Where the stomach is not utilised in this way, it is generally cooked after being cleansed, and is sold as an ordinary food. The intestines also are frequently treated by being cleansed, cooked, and then sold as "chitterlings."

Glue, Jelly, and Fertiliser.—The hoofs of the pig when not sold in the fresh state are digested and converted into gelatine, which is used for a great variety of purposes. The bones and other residues find their way into the fertiliser tank, where they are first of all digested, so as to save what fat they may contain, and the balance is then dried into an impalpable powder, which is used for fertiliser. Any blood also which is not used for food purposes is generally worked up as fertiliser.

* "Accounts Relating to Trade and Navigation of the United Kingdom."

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Pigs' Hides.—In Scotland particularly, there exists a considerable business in the tanning of pigs' hides. Curers of Wiltshire bacon do not remove the hide from the animal, but in the west of Scotland a considerable business exists in what is termed "rolled bacon," which involves the removal of the hides. These hides are very valuable for saddle leather, the binding of books, the making of purses and similar uses, and they are also used largely for the covering of furniture, for which purpose also the hair, which we saw is removed from the carcass at the very beginning of the manufacturing process, is also used. It is carefully freed from extraneous matter, and is utilised for the stuffing of furniture.

Everything in fact in connection with the pig is utilised, and there is no domestic animal which is of greater service to mankind. It seems strange, therefore, that although we utilise the pig and pig products so largely in the United Kingdom, there should be so little attempt made to increase our home production, and that we should go on from year to year relying upon the enterprise of foreign nations to supply our markets.

When speaking on another subject we saw that there was no provision in this country for giving technical instruction in connection with animal industries, and, as a consequence, these industries were very little understood. This seems to be at the root of the whole matter, as we unquestionably require in this country all these products which have been mentioned from time to time. It would therefore seem that the correct policy to pursue would be to institute such courses of instruction as would enable those who are associated with the meat industry fully to understand the technical processes connected with it.

This is a national affair, as it not only affects our food supply, but it touches also the question of employment, both skilled and unskilled, which would naturally follow upon the proper understanding of these various industries.

THE MYTH OF THE ARYAN INVASION OF INDIA.

By P. T. Srinivas Iyengar, M.A.,
Fellow of Madras University.

It is well known that most writers on modern history have not escaped the bias of their political or religious convictions, however impartial they have tried to be. In the selection of facts, in the method of marshalling them to point a moral, Hume was as much dominated by his Tory proclivities as Macaulay was by his Whig predilections. This applies in a small measure to ancient history, too. When the theory of the great civilised Aryan race was started, German patriotism claimed the Aryans to have been originally tall, fair, and long-headed, and the direct ancestors of the modern Teutons. French patriotism insisted that the language and civilisation of the Aryans came into Europe with the Alpine race, which forms such a large element in the modern French population; while the Italian Sergi, who belongs to the Mediterranean race evolved from an African stock, credits his own race with originating the Græco-Roman civilisation, and believes that the Aryans were savages when they invaded Europe. This colouring of history by the sympathies of the historian is not an unmixed evil, for to it we owe the rehabilitation of the character of Catholic sovereigns and statesmen by Lingard, and the explosion of the myth of the Saxon extermination of the Celts in England by leaders of the pro-Celtic movement of our own days. The eye of sympathy can alone pierce through the thick veil of interested misrepresentation, and emotion must co-operate with cold reason in the recovery of historic truth. It is not in history as in physical science where passion cannot blind the eye to facts. The Dravidians, the Dasyus, the Dasas—by whichever of these three names we may choose to designate the bulk of the people of India since historic times—have suffered from the misrepresentation of the Aryan Rishis, who composed the Vedas in the remote past, and of the ancient Indian commentators and modern European and American expounders of the sacred Scriptures of the Hindus. At the same time a mythical Aryan race has been built up out of scattered allusions in the Indian writings, and credited with the invasion of India, with the extirpation in some places, and absorption into the capacious Aryan fold in others, of the numerous tribes that occupied this vast continent. This theory appealed to the prepossessions both of those who believed in the repopulation of the world by the three sons of Noah, and of those who happen to speak a dialect of the "Aryan" speech. Being myself a Dravidian I propose to submit the theory of the invasion of India by the Aryan race, and of the extraordinary expansion of that race on Indian soil, to the test of reason inspired by sympathy for the Dravidian.

The comparative study of languages was born when it was discovered that the languages of

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North India, Persia, Armenia, and practically the whole of modern Europe, all belonged to one linguistic group. The wide spread of these languages, now generally called the Indo-Germanic, was explained by the supposition that a race of people that spoke the parent form of these languages inhabited the regions beyond the Hindu Kush, and in prehistoric times sent streams of colonists to Persia, to India, to Armenia, and on to Europe. The flush of enthusiasm caused by such a brilliant recovery of ancient history by the study of languages was heightened by the emotional satisfaction due to the notion that the Germanic races that dominate the world to-day were of the same stock as the haughty Brahman of India, who has, like Saturn, gloomed by himself in the horizon of India for several millenniums, has guided its destinies in fields intellectual and political, and been responsible for the grandeur of its philosophy, and for the political ineptitude of its people. The name "Arya," which originally belonged to certain Indian tribes that followed the fire cult in the valley of the Punjab, and spoke an ancient form of the language whose later literary form was called the Sanskrit, the polished speech, was extended to this imaginary race, partly because Vedic Sanskrit—the language of the "Aryas"—was believed to be the most primitive form of the Indo-Germanic tongues, and also because the word "Arya," whatever its derivative meaning, meant "noble," and was, therefore, a fit designation for the great race that was believed to have civilised Southern and Western Asia and the whole of the European continent, and to lead the van of the world's progress to-day.

Anthropologists soon pricked this Aryan bubble, and the great Aryan stock that peopled such a large slice of the world's surface soon became a small tribe that "Aryanised" Eurasia —*i.e.*, transmitted its language and culture to other races. The original habitat of this much-shrunk tribe was shifted in 1878 from the regions round the Hindu Kush to the shores of the Baltic by Pösche, and in 1889 to Russia by Taylor. In 1901, Sergi maintained that the Aryans were "of Asiatic origin," and "were savages when they invaded Europe; they destroyed in part the superior civilisation of the Neolithic populations and could not have created the Græco-Latin civilisation." * In 1911, Dr. Haddon, the greatest living authority on ethnology, carefully avoided the mention of the word "Aryan" in his admirable account of "The Wanderings of People" in Europe. The "Aryan race" has been given the quietus so far as Europe is concerned.

The theory of the invasion of India by the "noble Aryan," and of the extinction in some places and the subjugation in others of the "savage Dasyu," was promulgated by Max Müller, Muir and other Sanskrit scholars in the middle of the nineteenth century, and has since been an article of creed with writers of the history of India. In 1891 and 1892 Risley attempted to supply this theory with an anthropometric foundation. Dr. Haddon summarises the results of Risley's researches in these words: "The Aryan type, as we find it in India at the present day, is marked by a relatively long (dolichocephalic) head, a straight, finely cut (leptorhine) nose, a long, symmetrically narrow face, a well-developed forehead, regular features, and a high facial angle. The stature is fairly high . . . and the general build of the figure is well proportioned and slender rather than massive."† These investigations were based chiefly on "the distinction between the fine and coarse type of nose," and on the theory that in India the nasal index "ranks higher as a distinctive character than the stature, or even than the cephalic index itself." This "Aryan type" is found in the purest form in the Punjab valley and, in other parts of India, is mixed with another type, called by Risley the "Dravidian type." To account for the existence of a "pure Aryan type" of non-Indian origin in the Punjab valley, Risley assumes that the "Aryans" must have moved into India with wives and children, "by tribes and families without any disturbance of their social order," at a time when North-Western India must have been open "to the slow advance of family or tribal migration." ‡ The previous inhabitants of the fertile valley of the Five Rivers politely retreated before the advancing "Aryans," so that the purity of the "Aryan type" might not be polluted; and when the "Aryans" had moved into the Punjab, an obliging Providence ordered that the North-Western frontier of India should be "closed to the slow advance of family or tribal migration." Granting that all these miracles took place four thousand years ago, does subsequent history help us to believe that this Aryan type has remained unpolluted in the Punjab? Innumerable races have poured into India through the north-west in historic times. Persians, European Greeks, Bactrians, Scythians,

* Sergi, "The Mediterranean Race," p. vi.

† Haddon, "The Study of Man," pp. 103–4.

‡ "Imperial Gazetteer of India," I. p. 302.

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Huns, Afghans, Tartars, and Moguls, have all invaded India and settled in larger or smaller numbers in the Punjab, and been absorbed in its "Aryan" population. It requires great scientific hardihood to maintain that the nasal index of the Punjabi has remained unaffected by this age-long welter of races.

Apart from the measurement of noses, the only other source of information regarding the "Aryans" of India is the Mantras of the Vedas of the Hindus. These Mantras were composed by Rishis belonging to tribes who called themselves "Arya," and who called certain other tribes "Dasyu" or "Dasa." In later days "Arya" meant "noble," and "Dasa" meant "a slave," but it is not possible to find out with certainty what these words meant originally. The Arya and the Dasa fought with each other frequently; but as frequently Dasa tribes were auxiliaries of Arya tribes in fights among themselves. None of these conflicts appear to be incidents of a war of invasion. The Aryas do not speak of themselves as invaders gradually driving the aborigines before them, and wresting their land from them. There is no trace of the inveterate habit of people settling in a new land, that of importing into the land of their adoption geographical and personal names from their far-off original homes. In the Vedic hymns there is not even the slightest reference to or memory of any land outside India which the ancestors of the Aryas inhabited, no hint of the route through which they came to India, no phrase reminiscent of any foreign connection. Nor is there anything to indicate that they were gradually or suddenly moving hordes; the Aryas of the Vedic Mantras speak of themselves as people living in the Punjab valley, leading a settled life in towns and villages, ploughing the soil and tending their numerous herds of cattle. Their kings, petty chiefs, lords of towns, and heads of villages, their village assemblies, political and religious, their irrigation canals and their roads, their threshing-floors and water-troughs for cattle, all indicate that the Aryas lived in an organised society in the Vedic times. Nor were the Dasyus savages; it is true the Aryans do not refer to them in complimentary terms. But even from the contemptuous references to the Dasyus in the hymns of their Aryan enemies, we can easily infer that they were not savages, but lived like the Aryans in towns and villages. They owned many castles built of wood like the castles of the Aryas. Their chariots, horses, and cattle proved a standing temptation to the Aryas to attempt to raid them. Thus all the available evidence shows that the Dasyus were not savages, but at least as civilised as the Aryas. There is nothing in the Mantras from which the physical characteristics of the Aryas or the Dasyus can be inferred. There is a solitary word (*anasa*) used in reference to the Dasyu, which has been variously interpreted as "mouthless," or "faceless," or "noseless," and some scholars believe that this refers to the nose o the Dravidian, "thick and broad," and the formula expressing its proportionate dimensions, "higher than in any known race, except the Negro."* There are also references to the "black" colour of the Dasyu; but, in some passages, this certainly refers not to the human enemies of the Aryas but to demons whom they dreaded, and, in others, it is not easy to decide whether the word is used metaphorically or literally. To construct theories of racial characteristics on the shifting foundations of solitary phrases of very doubtful import, and in the total absence of any other evidence, is speculation run mad.

The only certain difference between the Arya and the Dasyu, frequently referred to in the Mantras, is one of cult. Whatever the etymological meaning of the word "Arya" may have been in the Mantras, Hindu commentators on the Veda, from the authors of the Nirukta down to Sayana, have explained it as "the son of the lord," "the wise performer of the (fire-)rites," "wise worshippers," "practisers of fire-rites," "he who has attained a high position through the performance of fire-rites." On the other hand, innumerable passages in the Mantras describe the Dasyu as "devoid of (fire-)rites," "opposed to the (fire-)rites," "without Indra," "offerers of worthless libation," "fire-less," etc. From this it is evident that the Dasyus incurred the hatred of the Arayas, because they did not worship the Aryan god Indra, and did not, like the Aryas, offer sacrifices through Agni, the fire-god, the mouth of the Aryan gods and the mediator between them and their human worshippers. The Dasyus, like the Aryas, killed animals in sacrifice to their gods, and we may presume that, like the followers of many modern non-Aryan Hindu cults, they poured the blood of the slaughtered victims at their altars. The Dasyus must have hated the fire-rites of the Aryas as a strange innovation, and they are described as "revilers" of the (Arya) gods and rites, and are said to have frequently interrupted their

* Haddon, "The Study of Man," p. 104.

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performance. The Nirukta defines a Dasyu to be one that "destroys fire-rites." Besides offering animal sacrifices through fire there was a special libation that distinguished Arya worship. More than the flesh of bulls and goats, Indra, the Arya god, loved the intoxicating juice of the soma plant,* and his worshippers, inspirited by liberal draughts of soma juice, ventured forth to raid Dasyu settlements, and bring back their cattle and their women as prizes of war. In comparison with soma, the offerings of the Dasyus to their gods were regarded by the Aryas as "worthless oblations." The Aryas also frequently refer to the Dasyus as "prayerless," "enemies of prayer," "those that do not employ hymns." This indicates another line of cleavage of cult between the Aryas and the Dasyus.

All Aryan sacrifice, of animal or of soma, of corn or of cake, was accompanied with recitations of "prayers," either composed for the occasion or taken from a pre-existing stock of Mantras. These Mantras were composed in an early literary form of the tongue that later gave birth to classical Sanskrit and the many vernaculars of North India. This tongue must have been the language of the Aryas, and we may assume that the Dasyus spoke dialects other than those of the Aryas. Besides the Indo-Germanic, there have existed in India from early times dialects of two other linguistic families, the Dravidian and the Munda. Though there is nothing in the Vedas to indicate that the people there called Dasyus spoke these and not the dialects of the Aryas, yet we may assume that the fire and soma cult of the Aryas was exclusively associated with Vedic speech. This is by no means certain, because the non-Aryan Hindu cults in which animal sacrifices are offered to gods not through fire exist to-day as much in those parts of India where Indo-Germanic dialects are spoken, as where the Dravidian and Munda dialects prevail. As these sacrifices were not and are not accompanied with prayers, we do not possess any evidence of the languages spoken by the followers of these cults in early times.

The fire and soma cult and the Vedic speech, then, and not differences of race, distinguished the Vedic Aryas from the Vedic Dasyus, in so far as we can judge from the Vedas. There remains to be discussed the question whether this cult and this speech were suddenly transplanted among the Aryas by any considerable body of foreigners, or whether they were slowly spread among them, undergoing changes in the process. The mere entry into a country of a foreign cult and a foreign tongue does not prove any appreciable ethnic disturbance of it. Dr. Haddon says: "It is astonishing with what ease a people can adopt a foreign language, which, however, almost invariably undergoes a structural and phonetic modification in the process."* It is well known to students of comparative grammar that the Vedic parent of Sanskrit is profoundly different from the original Indo-Germanic. In this, as well as in certain respects of structure, most of the Euro-Indo-Germanic dialects are nearer the original tongue than the Vedic speech. This shows that the Vedic tongue came to India as a foreign language, and underwent there a levelling down of its vowels and other alterations. Now, as regards the cults associated with this language. The soma plant is described in the Vedic Mantras as growing on distant hills, like those of Gandhara, and generally procured with some difficulty, and stored in a dried-up form as *charas* is to-day. In later times, when the centre of the fire cult shifted into the heart of India, the soma plant could not be procured, its identity was forgotten, and substitutes came to be used in its stead. The soma cult flourished in ancient times in Persia. We may thence infer that it found its way into India from without. But once it was introduced, it underwent a great development in this country. The Aryan Rishis appreciated the virtues of the soma juice so much that a large part of the Vedic Mantras is devoted to its praise; King Soma attained a distinguished position in the Vedic pantheon, and the soma sacrifice became the principal rite of the Brahman. The fire cult, like the soma cult, existed in ancient Persia, but with this difference, that to the Persians fire was so holy that throwing offerings into it would pollute it; so parts of the bodies of slaughtered animals were shown to the fire and thrown aside. As in India the offerings to gods were burnt out in the sacrificial fire, the fire cult underwent a fundamental change in this country. The gods of ancient Persia, as well as those of another people that spoke an Indo-Germanic tongue and "conquered Mitani (in the westward bend of the Upper Euphrates) by about 1500 B.C.," belonged to a stage of culture a little "earlier than that indicated in the *Rig-Veda*."† In other words, when the Vedic

* The soma plant has not yet been identified, but, judging from the methods of preparation of soma and its effects on man as described in the Vedas, it must be akin to the *bhang* (hemp) of modern times. The soma juice was drunk *without being fermented*, and mixed with milk or curds, or was cooked with flour.

* Haddon, "The Wanderings of Peoples," p. 10.

† *Ibid.*, p. 21.

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tongue and its associated mythology reached India, gods like Mitra and Varuna, who till then had been supreme, retreated to the background, and their place was taken by Indra, the god *par excellence* of the Indian Aryas.*

Very little of the mythology associated with the ancient Indo-Germanic speech seems to have reached India. The only god common to the Vedic Aryas and the races that spoke Indo-Germanic dialects in Europe is Dyaus, and Dyaus is scarcely worth the name of god in the Vedic pantheon, being so little removed from the physical sky. Then, again, Mitra is practically the only god common to the Vedas and the Zend Avesta, and is in both literatures a subordinate person. Indra, the chief god of the Indian Aryas, is a minor demon of the Iranian Aryas. Varuna was unknown in Persia. All other Indian gods are of pure Indian origin, Rudra, Vishnu, Aditi, Maruts, Asvius, Ushas, etc. The name of the fire god, Agni, is also Indian, though evolved from an Indo-European root, the corresponding Persian god being Atar. It is impossible to discuss here how many of the Vedic gods were borrowed from the people of India, and then "Aryanised," and how many were evolved on Indian soil from pre-Aryan sources latent in Aryan speech, but the fact is striking that so few Aryan gods came to India along with Aryan speech.

From this we see that the language and the cult of the Aryas were borrowed from without, and profoundly altered on Indian soil. If this cultural drift had been accompanied by any appreciable racial drift, if the cult and the language had been brought into India by any considerable body of foreigners, who formed a race by themselves, and lived apart from the native races, neither the cult nor the language would have undergone such serious alterations as they have, but would have remained relatively pure. Hence we may conclude, with a fair degree of certainty, that in the second millennium B.C. a foreign tongue and a foreign cult drifted into India, and were adopted by certain tribes, later called Aryas, among whom the cult and the speech developed in new ways, and distinguished the tribes that possessed them from the other tribes of this country.

Even among the Aryas this cult was but superimposed on, and did not oust, pre-existing cults. It mingled with the previous totemistic cults implying the worship of animals—like the cow, the hawk, and the serpent, of trees like the *ficus religiosa*, of hill divinities, and river goddesses; it also mixed with innumerable religio-magical practices based on animistic beliefs, all which are abundantly referred to in the Vedic Mantras, and are prepotent to-day in India. But the fire-priests, some of whom, like the Rishis, composed hymns and instituted rites, and others like the Hota, the Adhwaryu, etc., assisted at the ritual, dominated the land from early times, and secured the patronage of kings. As they alone have left literary monuments, they loom large in the early history of India; but we must not forget that the bulk of the people of India followed, and still follow, the non-Aryan "fireless" rites of the Dasyus, and the fire-rite was at no age more than the semi-esoteric cult of the few. The spread of the fire cult into the lower Ganges valley and into the Deccan has been mistaken by historians for the spread of the "Aryan race." There is no evidence of a racial dislocation in India in these early days. So far as is known the bulk of the people was stationary. The story of the "Ramayanam" has been by some interpreted to refer to an ancient invasion of Southern India by the "Aryans." But how the mythical defeat of a King of Lanka by a solitary ascetic prince, exiled from his kingdom, helped by his brother and by a South Indian monkey tribe, can mean the migration of a North Indian people, passes comprehension. In all the early books there is evidence of the spread of the fire cult and the gradual increase of the power of the fire-priest, but none of any racial drift. Even this gradual extension of the fire cult did not mean the adoption of it by the people, such as takes place when Christianity or Islam spreads in our days, but merely meant the predominance of the Brahman and the adoption of forms of State fire-rites like the *Rajasuyam* or *Asvamedham* by kings for special public purposes. The fire-rite could not spread among the people, for from pretty early times the Brahman alone was competent to act as the fire-worshipper, and kings could be admitted to the fire-worship, even in sacrifices peculiar to

* The comparative study of religion has brought out the fact that the movement of religious thought in early times was not from polytheism to monotheism, but the other way about, from tribal monotheism to inter-tribal polytheism. In his "Religion of Egypt," p. 4, Professor Flinders Petrie says: "Wherever we can trace back polytheism to its earliest stages, we find that it results from combinations of monotheism." The polytheism of the Vedas is one of the many proofs that the Vedas refer not to the beginning of any cult, but the culminating stage of many pre-existing tribal cults, which had coalesced chiefly out of political causes. This is the real explanation of the perplexing henotheism (as Max Muller called it) that runs throughout the Vedic Mantras. At the time of the composition of the Vedic hymns, the tribe that worshipped Indra seems to have acquired predominance over the tribes that worshipped other gods.

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kings, only after being temporarily invested with Brahmanhood, and even they could approach only the outermost of the sacrificial fires, that at the entrance to the sacrificial hall. This fire cult gradually died out even among the Brahmans, and to-day but faint relics of it are followed in a half-hearted manner in Brahman homes.

But from early days the name "Arya" —which originally belonged to the tribes that had adopted the fire and soma cult—was transferred to the higher classes of the Indian peoples, who, whatever their beliefs and religio-magical practices, acknowledged the theoretical supremacy of the fire-priest; so much so that when Gatama Siddhattha founded an order of ascetics (*Bhikkus*) open to Kshatriyas, in imitation of the Brahman order of Sanyasis, his *dhamma* was called Ariya (Arya). When, in later times, modern Hinduism rose with its numerous castes each characterised by endogamy, and with its beliefs and practices conglomerated out of every cult that had grown in ancient India, the term Arya was extended to every clan and every tribe that could lay claim to a high social status, and could enforce that claim. And, lastly, when the theory of the "Aryan Invasion" of India was promulgated by European scholars, it was seized with avidity by the "higher castes" as affording a historical basis to their pretensions of superiority to other castes. And the result is that every member of every caste that calls itself "Aryan" believes that blue Aryan blood flows in his veins. Emotion plays a large part in the manufacture of history, and any theory that soothes the vanity of a people is straightway elevated to the rank of a fact; so to-day a scientific examination of the bases of the theory of a superior Aryan race is resented more in India than anywhere else in the world.

European Sanskrit scholars, who have mostly kept themselves aloof from the world's progress in the science of ethnology, still speak to-day of the "Aryan" invasion of India, and the supersession of the aborigines by the "Aryan," as if it were a fact. They do not realise that, as Dr. Haddon says, "the so-called Aryan conquest was more a moral and intellectual one than a substitution of the white man for the dark-skinned people—that is, it was more social than racial." But it is regrettable that Dr. Haddon, the cautious ethnologist, the most eminent authority on the social drifts of the world, should yet give his unhesitating adhesion to Risley's theory that "Aryans, perhaps associated with Turki tribes," moved with wives and children into the Punjab about 1700 B.C., and completely displaced the previous population, and, what is more curious, their noses have remained unaltered since, notwithstanding that the Punjab has been the cockpit of races since the dawn of history almost down to our days, thus setting at naught at the same time the evidence enshrined in the Vedic Mantras and the necessities of the geographic control of all human affairs.

When all is said, there may still remain in the minds of some the feeling of doubt how a cult or a speech can travel by itself. The fire cult and the speech of the Aryas must have come to India in the wake of a peaceful overflow of people from the uplands of Central Asia into the plains of India, or been the result of a peace-intercourse between the Indian people and foreigners. But theories cannot be built on metaphors, and there is absolutely no evidence at present to guide to a solution of the problem.

ALGERIAN WINE PRODUCTION.

The wines all along the coast of the Algerian province of Oran, when properly made, are of good quality, and greatly sought after from a commercial point of view. The wines produced from vines grown in the plains in the vicinity of Oran (red soil, clay and flint), are of average colour, and sometimes have a sharp taste. Those from the hills (clay and chalk soil) are finer in quality and stronger. To the west of Oran, the vineyards on the coast, and particularly those of Bou-Sfer, give wine of a superior quality. At St. Cloud (east of Oran), grape gathering commences earlier than elsewhere, and the wine shipped to France before others is used to freshen up the French wines of previous years, rendering them again fit for commercial purposes. The St. Cloud wines are strong and have a rich colour, but are sometimes a little sweet. At Perragaux the vines produce a larger quantity of wine, but the quality is below the average, and the greater part of it is distilled. The same characteristics which are more or less common to all the wines of the Oran district, are also to be found in those of Mostaganem. They are, as a rule, a little weaker, their colour is not so dark, generally they are of a more delicate flavour, and they have a decided taste of the fruit. In these different regions of the Oran coast, the wines are made from excellent grapes of perfect ripeness, but they are regarded as inferior to those of the Sahel, which are similar. This inferiority, according to the American Consular Agent at Oran, is due solely to the unfavourable conditions under which the Oran wine is made. The vineyards of the inland regions, Mascara, Tlemcen, and Sidi-Bel-Abbes, produce wines which are of decidedly finer quality; they also possess a stronger, more decided taste of the fruit, and are brighter in colour. Their

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superiority is due principally to the altitude. In these high regions grape-gathering does not commence until the end of September or October. Fermentation being effected under more favourable conditions, the wines are of better quality. The wines produced in the district of Tlemcen are of great delicacy, and rich in colour. They keep well. The most important centres of production are Tlemcen, Mansourah, and Ain-Fezza. In the district of Sidi-Bel-Abbes, the vineyards are half in the plains, half on the hills. Some are exposed to the spring frost, which at times destroys all the young shoots. The Sidi-Bel-Abbes wines are good, fresh, and of a rich colour, which they retain fairly well. Those from the hills are the best. Apart from the vineyards surrounding the town of Sidi-Bel-Abbes, the most important places in that region are Sidi-Lhassen, Oued-Imbort, Sidi-Ibrahim, and Ain-Trid. The Mascara vineyards are old, but they give the best wines in the province of Oran, very strong, of excellent quality, mellow in taste, and of a rich velvety colour. The white wines on the hills (clay and chalk soil) are produced mostly by native plants that yield remarkably good wine, which is considered among the best in Algeria. The wines of Saida, with less colour, vie with those of Mascara, but the superiority is rather on the side of the latter. Between the wines of the coast and those of the inland region, are those of an intermediate section, of which the town of Ain-Temouchent is the centre. The vineyards there, owing to the fertile volcanic soil, the situation and the altitude, can be compared with those of Sidi-Bel-Abbes and Mascara. The wines possess a high degree of alcohol, and are of a bright colour. They have the same defects as the wines of the coast but to a smaller extent, but they have not the same amount of acidity. The best places for their production are Hammam-Bou-Hadjar, Les Trois-Marabouts, Sidi-Daho, and Chabat-el-Laham. The production of wine in 1910 amounted to 58 million gallons, distributed as follows:—Oran, 38 millions; Bel-Abbes, 14 millions; Mascara, 3 millions; and Tlemcen, 3 millions.

THE RUBBER INDUSTRY OF THE CONGO FREE STATE.

The Belgian Government is making a special effort to encourage to the utmost the cultivation of rubber in the Congo Free State. Three expeditions went out in 1911 to the district of the Equator and discovered several tracts which seemed to meet all the requirements necessary to the cultivation of the *Hevea brasiliensis* (Para rubber). At the same time, the planting of hevea had already been tried in the five stations of the Bangala and in two stations of Stanleyville. The American Consul-General at Antwerp says that some of these plants, ten years old, have now reached the period of seed-bearing. Last year a considerable number of seeds were harvested and used immediately; the surplus seeds were held at the disposal of the natives and private individuals who solicited them. Experiments in tapping recently made at the Botanical Gardens of Eala, on hevea trees, six and a half years old, gave 515 grammes (1·13 lbs. avoirdupois) of dry rubber per tree. Other experiments in tapping made elsewhere gave excellent results—for example, at Boma, Kitobola, Coquilhatville, Bambili, and Niangara. It was found that coagulating the rubber sap by plunging it in hot water still gave the best results, and is much more effective than the slow process of allowing it to settle. The cultivation of several other species of rubber trees is being experimented with, but none equals the *Hevea brasiliensis* in point of production, growth, and quality. It may therefore be taken as settled, says the Consul, that the *Hevea brasiliensis* is the best adapted for cultivation wherever the rainfall is sufficient for its growth. With regard to Congo rubber, there is a constant demand for the highest grades, which, however, are becoming very rare; and one of the first effects of free competition would seem to be a notable lessening in the care given to harvesting and coagulating the rubber. The greater part of the Congo rubber imported into the Antwerp market comes from districts given up to private collection. It is feared that incessant harvesting of rubber in the Congo forests will impoverish the growth. Rubber experts therefore strongly advocate the systematic and well-organised planting of rubber trees, not only by the public authorities, but also by private individuals. As yet, the trade has not decided upon the best form in which the crude plantation rubber should be presented for sale.

THE STRAW BRAID AND STRAW HAT INDUSTRY OF TUSCANY.

The manufacture of straw hats and hat braid has been a flourishing industry in the province of Florence for more than a century. At present over 90,000 workers are employed in making, gathering, sorting and shipping the hats and braids from this district. In the province of Florence are upwards of one hundred factories devoted to braid work, and more than thirty making trimmed and untrimmed hats. Only some 4,000 persons are regularly employed in these factories. The outside workers are comprised under two headings, which refer only to their manner of living — 65,000 are "pigionali," *i.e.*, live in rented houses, usually near some factory, and 19,000 are "coloni," *i.e.*, tenants of small farms worked on shares. More than 56,000 women and 26,000 girls under age are engaged in straw work. They work for the most part at home, and the making of hat braid is, in the case of "coloni," done in addition to the usual work of the day. The most important branch of the local straw industry is the working of "paglia Fiorentina," or "nostrale," from which the famous Leghorn hats are made. The braid used in Leghorn hats is composed of thirteen threads. The manufacture of hats from "paglia nostrale"

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is essentially a Florentine industry, and one in which there is no competition abroad. It is customary to order these hats by the number of "giri" or widths of braid to be used. The person making the braid then winds and sews the widths until the requisite number of "giri" has been reached. Ordinarily, Leghorn hats are sold in their natural colour, which is a light yellow. Some also are bleached by a process of washing followed by six or seven weeks' exposure to the sun. "Paglia nostrale" is also made to some extent in braids of five and seven threads. These lighter braids are used in the manufacture of broad-brimmed hats for women. In the Emilian Mountains, a straw, different in type and finish from the Florentine, is very largely worked. The hats of this straw in and around Bologna and the neighbouring villages of Monghidoro, Monzani, Lojano, Monteruggo, Filigare, etc., are called "punta" to distinguish them in the trade from the Florentine "nostrale" hats. This straw is plentiful in the Emilian Mountains, and is much rougher and coarser than the Florentine straw. Formerly "punta" hats were exported in their rough form, but of recent years they have been forwarded to the Florence district to be properly finished for the market. The finishing process renders them more saleable, though it increases the cost of each hat. Another important straw worked in Florence is called "truciolo." It is a woody product, not native to the district but grown in Russia, and made into threads of various sizes in Bohemia. Locally the "truciolo" is plaited into different types of braid. Another foreign straw worked is "japon." Work in this straw is ordinarily limited to braids, but some few exporters make up a considerable number of fancy hats for women in accordance with the fashion of the moment, in order to take advantage of the cheap hand labour in the district of Florence.

CORRESPONDENCE.

A SACRED PEACOCK.

The gift to the British Museum by Mr. Schwaiger, of Delhi, announced in the *Times* of July 8th, of "A Sacred Peacock"—it being "a steel-wrought peacock," believed to be the *Malik Taos* [ταῶς of Aristophanes and Athenæus], *i.e.*, "The Lord Peacock," or *Malik al Kuwat*, *i.e.*, "The Lord Angel" of the Yezidis, or so stigmatised "Devil-Worshippers" of Mesopotamia—has created so lively an interest, that I am encouraged to contribute a passing note on the subject for the *Journal* of the Royal Society of Arts.

The best account of this strange sect, whose religion is a jumble of paganism and Judaism, and Christianity, and Islamism, is still that given in his various volumes published from 1843 to 1853 by Layard, who visited these Khurdish people in their most eldritch abode and chief centre of worship about the Sinjar Mountain, near Mosul; the characteristic brass work of which town, the modern representative of ancient Nineveh, goes to this day throughout Syria by the commercial denomination of *ninavi*. Layard graphically describes their white-spired "Temple of the Sun," Shaikh-Shams [compare "Beth-Shemesh" of Joshua xv. 10, xxi. 16, the modern Ain-Shems, *i.e.*, "Well of the Sun," and xix. 22, and 38, both unidentified, and Jeremiah xliii. 13, identified with On, the Egyptian Heliopolis], and the drove of white bulls attached to it. Shaikh Shams is, of course, the analogue of the Babylonian Shamas, the brother and consort of Ishtar [Ashtaroth], as Shaikh Sin is of the Sabæan, and Chaldæan, "Moon-God," their father, who is said to give his name to Mount Sinai; although I myself incline to the assumption that the latter derives its name from the scrubs of Senna [*sanna*] to be found along its sequestered gullies, and adown its sun-scorched slopes. The river Indus is named also Abba Sin, but Sin here is a clipping of Sindu, the Indian variant of Hindu, meaning simply "water," or "river."

As to the suggestion of "A Sacred Peacock" being an idol of the Yezidis, it is material that its "provenance" should first be indisputably proved, and its history traced back to a date before the establishment of British rule, and consequent generation of forged "antiquities," in India. Had I been shown the illustrations of it in the *Daily Graphic*, the *Daily Mirror*, and the *Daily Mail* of July 9th, without knowing anything of the attribution to it, in the *Times* of July 8th, of an Euphratean source, I should have said that in all probability the place of its production lay in the Punjab and at Lahore; and I would further have ventured to hint that at some time—any time between Arungzib and Nadir Shah—it had possibly been in the treasured possession, as a tribal god, of one of the great princes of Rajputana; for they all worship Karttikya, the Hindu "God of War," in his name of Kumara, "The Boy," "The Prince," and in the very form of a peacock, called by them Paravani [? "of the Spread-fan"; compare also the Latin "pavo" and "pavoninus"], the *vahan*, *i.e.*, "vehicle" [compare "van"] of Karttikya, whose consort is Sina. This peacock is also used as an armorial bearing by many of the Rajputs. Surely, if the so said "Sacred Peacock" in the British Museum had been of Euphratean origin, it would have been fashioned more after the model of the bird-crowned brazen lamps of the temples of South-Western and Southern India, which, like so much of their furnitures [utensils, hangings, etc.] are obviously of Assyrian, and earlier Babylonian, and yet earlier Chaldæan inspirations.

The peacock, in Hindu mythology, is also the *vahan* of Sarasvati, the consort of Brahma, and "Goddess of Learning," although it is sometimes replaced by a goose! and peacock's feathers are everywhere in India used in exorcisms and other magical rites.

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The earliest notice in Europe of the peacock is in the passages in Aristophanes [444–380 B.C.] alluded to above:—"Acharnians," line 63: "I'm sick of ambassadors and their peacocks"; and "Birds," line 269: "By Io!—surely not a peacock?" Athenæus is not worth quoting in the present connection.

As to the etymologies referred to above, the Latin "pavo," in Old Latin "pavus," is but the Greek ταῶς with the "t" changed to "p," which becomes, through the Latin of about A.D. 600, "paonem," the Spanish *pavon*, and French *paon*; and through Teutonic channels the German *pfau*, and Old English *pawa*, and our new English peacock, pea-hen, and pea-fowl—all these [and the Persian *taos*] originating in the Tamil *toggei*, the *tukkyim*, as is held, of 1 Kings x. 22, and 2 Chronicles ix. 21: "Every three years came the navy [or "ships"] of Tarshish [of the Phœnicians] bringing gold and silver, and ivory, and apes, and peacocks" [from Ophir, *i.e.*, the "Orient," including India].

Finally, the arts-craftsmen of North-Western India are exquisite—it is in my heart to say, per-exemplary—forgers of "antiques" of every description. Sir Bartle Frere, in 1876, brought home from India sixty gold coins, as of the Bactrian Greeks. Every one of them was a forgery. Later, several hundreds of copper, and silver, and gold coins, said to be of the Bactrian Greeks, were submitted to me; and again all the really interesting ones of the collection were forgeries. A grandfather will forge the coins, and at his death make them over to his son, with instructions, at *his* death, to hand them on to *his* son, for sale to the good English and better American "curio hunters."

GEORGE BIRDWOOD.

NOTES ON BOOKS.

MODERN PRACTICAL DESIGN. By G. Woolliscroft Rhead, R.E., Hon. A.R.C.A. London: B. T. Batsford. 7*s*. 6*d*. net.

This is a very comprehensive volume, dealing with plant-form as a basis of ornament, and the ornamental filling of given spaces as well as design for various crafts and processes of manufacture. Mr. Rhead is one of the examiners to the Board of Education, and he evidently knows what has up to the present time been expected of students who sit for the design examination, and has produced a practical and, in the main, a trustworthy text-book for their use. The book is well got up, and the numerous modern examples of craftsmanship with which it is illustrated are interesting and well chosen; indeed, the section which deals with craft work, though the limitations of space prevent it from being very full, should prove a useful introduction to the various processes—woodwork, metalwork, book decoration, pottery, and stained-glass making, etc., described in its pages.

The chapters devoted to design and space filling are, however, far less satisfactory. The author is evidently an enthusiastic admirer of nature, and he seems to think that natural forms can be turned into satisfactory fillings for panels, and even into designs for borders and repeating patterns, with far less treatment and adaptation than really goes to the making of a design worth the name. It is a common failing with students to imagine that in nature they have to their hand ready-made ornament, and that a careful study from nature can be worked up into a pattern. They want teaching that all that nature offers is suggestions—the raw material which has to be transformed into a design by the mind and hand of the artist. Mr. Rhead's book will not help them in this direction. Again, nature, it is true, is one of the chief sources, indeed the chief source of ornament; but it is not the only one. The designer who wishes really to know his trade must have studied, side by side with nature, the work of the masters who have gone before him, and in doing that he will discover not only how to treat natural forms, but also the beauty of various types of ornamental design into which nature enters but little, or not at all. With this side of design Mr. Rhead has apparently no sympathy—indeed, one might read his book and hardly be aware that it existed at all. In fact, we are led to suspect that, designer as he is by training, he is by instinct and conviction a lover of nature rather than of pattern.

HOW TO DRIVE A MOTOR CYCLE. By "Phœnix" (Chas. S. Lake). London: Percival Marshall & Co. 6*d*. net.

This little handbook is, as the author describes it, "a popular explanation of the handling and management of a motor bicycle on the road and at home." It is designed for those who, having some knowledge of an ordinary bicycle, now come into possession of a motor bicycle for the first time. Starting with the delivery of the new machine, Mr. Lake proceeds to describe the preliminaries to starting the engine, styles of mounting, the different methods of driving (with and without a side car), lubrication, roadside adjustments, and repairs —in short, all the points on which a novice is likely to need advice and assistance. Mr. Lake has a few words to say about the use and misuse of the "cut-out." Probably nothing has done more than this device to render the motor bicycle unpopular on the high road, and the noise which it makes is certainly such a serious objection that in the opinion of many the authorities would be justified in declaring it illegal. The difficulty is that up to the present it has been found impossible to devise a silencer which allows the engine to run very quietly and yet be free from back-pressure. No doubt this problem will be solved in time, but if in the meanwhile motor bicyclists would take Mr. Lake's advice, and only use their exhaust cut-outs when on the open road and with nobody near to be annoyed by the nuisance which they

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undoubtedly create, we should hear a great deal less abuse of the motor cycle.

Mr. Lake, under his pen-name "Phœnix," is well known as a writer on subjects connected with motor cycling; he is also a practical motorist of great experience, and he has the gift of imparting information in a simple and lucid manner.

GENERAL NOTES.

Remains of Gigantic Animals.—The Natural History Museum has recently received some remarkable specimens or casts of specimens of extinct animals of exceptional size. One of these is a great horned dinosaur known as Triceratops. It is from the upper cretaceous strata of Wyoming, U.S.A., and its chief peculiarities are two enormous horns over the eyes and a great shield over the back of the skull, protecting the neck. The skull, with the shield, is about five feet long. The jaws are furnished with a large number of teeth, except at the anterior extremities, where they end in a kind of beak. There are also two extremely interesting accessions to the Museum which have not yet been mounted, and which will not be on view for some time to come. One of these is a cast of a bone belonging to an animal discovered in German East Africa. It has been presented by the Berlin Museum, where the original is preserved. The creature in question is a large dinosaur, and is known as Gigantosaurus. Of the particular individual of which the bone has been found only the humerus or upper arm and the scapula or shoulder-blade exist. The humerus is seven feet long. If the relative proportions of the limbs of this animal corresponded to those of the great diplodocus, which was found in America, and of the skeleton of which a replica, presented to the Natural History Museum by Mr. Carnegie, is preserved at South Kensington, the thigh bone of this East African dinosaur must have been twelve feet long. The other large animal to which reference is made above, and which is not yet available for inspection, is a dinosaur called Tyrannosaurus. It comes, like the first specimen mentioned, from the upper cretaceous beds of Wyoming. The Natural History Museum has a very fine cast of the skull of this creature, which was a carnivorous animal. The whole skeleton is in the American Museum of Natural History in New York. The skull of this dinosaur, which is probably the largest specimen of its kind known to science, is four feet four inches in length. The mouth opened for almost the whole length of the skull. The longest of the teeth are five or six inches in length. They are sharp and pointed, and the whole aspect of the beast is terrible, even at this distance of time. The animal, which had exceedingly small fore limbs, sat upon its hind legs like a kangaroo.

Continental Fruit Prospects.—The Board of Agriculture and Fisheries have received reports from His Majesty's Consuls on the condition of the fruit crops in certain districts in Germany, France, Belgium, and Holland. The Consul-General at Frankfort-on-Main reports that this year's crop of nearly all kinds of fruit in Germany will probably be a small one. The fruit trees and bushes have suffered heavily through the great drought of 1911, subsequently through the sudden change of temperature from warmth to intense cold in February, and finally through the spring frosts in April and at the beginning of May. In many districts a complete failure of the fruit crops is certain. In the district of Bühl, in Baden, the centre of the early plum cultivation, the loss sustained by the proprietors of vineyards and orchards is estimated at from £50,000 to £100,000. As to France, there is, generally, a great deficiency in every kind of fruit for exportation. There will only be available for export to the United Kingdom this year at most half the ordinary available quantities of pears, cherries, apricots, and apples; but of prunes, peaches and black currants there will only be one-third, if as much, and their price will probably be about one-third higher than last year. The plum crop will be bad. In Belgium prospects are very meagre. Early frosts destroyed the bloom, and the subsequent prolonged period of drought hindered the formation of the fruit. The crop is likely to be poor in quality and restricted in quantity. Fruit prospects in Holland are generally satisfactory.

The Production of Ipecacuanha in Colombia.—Ipecacuanha, a trailing plant, thrives best in clay soil along the banks of rivers. While it requires a great deal of moisture, it cannot live under water, and consequently in Colombia it is found in its best development in regions where the rainfall is abundant, but where the rivers do not overflow. The Sinu River is the ideal region for ipecacuanha. The plant is found in abundance from near the headwaters of this river to near the city of Monteria, about sixty miles from the coast, where the clay formation, which ipecacuanha seems to demand, stops, and below which point the river is subject to periodical overflows. The growth extends to several miles on each side of the river, and also to the more important tributaries of the Sinu, the Esmeraldas, Verde and Manso Rivers. In regions where the water is excessive, such as the valley of the Atrato, the plant, though found, has a poor growth and is of an inferior quality. In gathering ipecacuanha the whole plant is uprooted and the thin and soft rootlets are thrown away, and these discarded rootlets serve for reproduction, becoming in a year well-developed plants with valuable roots of their own. Ipecacuanha is not an object of cultivation in Colombia, though there is no reason why it should not be, except the fact that it is found wild in such abundance.

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Journal of the Royal Society of Arts.

No. 3,114. VOL. LX.

FRIDAY, JULY 26, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

MAGNESIAN CEMENT IN INDIA.

By C. H. B. Burlton, C.E.,
Late Superintending Engineer, Indian P.W.D.

The largest known magnesite deposits in India are situated in the Salem district of the Madras Presidency, and these are owned and are being worked by the Magnesite Syndicate, Limited, London. Magnesia, or oxide of magnesium, the calcined product of the crude mineral magnesite, is manufactured on the spot, where the necessary kilns have been erected.

As the properties of magnesia in relation to its engineering uses are not generally understood, the object of this paper is to bring to notice an industry which can produce a building material cheaper than and, for certain works not under water, vastly superior to the best class of Portland cement, while recent experiments point to hydraulic possibilities.

The merits of magnesia are appreciated by the Americans, the Germans, and the British in the United Kingdom, who import it from the Salem deposits. But in India itself, where the deposits occur, magnesite is not in common use. Yet it may be conceded that the question of utilising the product of a native industry in preference to importing a foreign material depends on whether the native product is for the purpose required as cheap and as good as the foreign material.

The importation of products which do not show unquestionable superiority over those locally procurable should not be encouraged, for it is practically always advantageous for political and economical reasons to make use of the resources of the country concerned.

Sir Valentine Chirol has, in his "India's Unrest," emphasised the importance of investigating the resources of our Eastern Empire as a means of advancing its economic development, which is at present hampered by the preference given to imported goods. He even traces some of the disaffection in India to the inadequate support of native industries, on behalf of which the energy displayed by Sir George Birdwood and others has been conspicuous for the last thirty years, while the soundness of their views has been recognised officially. So far back as 1883, in fact, a resolution was passed by the Government of India that the utmost encouragement should be given "to every effort to substitute for articles now obtained from Europe articles of *bona fide* local manufacture or indigenous origin." Partial effect has, no doubt, been given to these views—as regards Madras at least—by the appointment of a Director of Industries in the person of Mr. Alfred Chatterton, an engineer of ability and high scientific attainments. But Mr. Chatterton's experiments have, it is believed, been confined almost entirely to the manufacture of goods in aluminium, a metal whose scope in India is limited at present to ornaments and vessels that are used for domestic purposes; whereas the magnesia industry of which Salem is the headquarters concerns works of general utility.

Particulars of the Southern India Deposits.

Salem, the principal town of the district in Southern India from which it takes its name, is situate half-way between Madras on the east coast and Calicut on the west, being about 200 miles distant from either port; and the deposits occur in two so-called "chalk hills," some 2,000 acres in area, lying to the north of the town of Salem and within a mile of the railway. The formation of these hills is mainly dunite with outcrops, beds, and veins of magnesite, from the white appearance of which their designation "chalk" is taken.

Mr. C. S. Middlemiss reported on these deposits in 1896, when Superintendent of the Geological Survey of India, describing the areas of the hills as "two such great intrusive masses of olivine-chromite rock and other olivine-bearing rocks, which, from their containing little or no felspar

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or quartz, belong to the peridotite or ultra-basic group of rocks, such as dunites, picrites, etc. The rocks, owing to the unstable mineral olivine, have undergone enormous mineral change, whereby, first, the dunite became serpentinised more or less completely, and, secondly, the serpentinised product was further altered with the formation of magnesite, chalcedony, etc."

Use of Magnesia as a Cement.

But seventy years before Mr. Middlemiss wrote his report Dr. Macleod brought these deposits to the notice of the East India Company, from whom he obtained an honorarium for his researches on the value of magnesia as a cement, a great deal of which was used for repairing the counterscarp of the moat of Fort St. George, Madras. Subsequently, Captain—afterwards Sir Arthur—Cotton, R.E., followed on the same lines. It is, therefore, remarkable that India, with the material for an admirable cement available within her boundaries, should not make full use of it herself, instead of allowing it to be exported to other countries as she does.

Magnesia versus Portland Cement.

Lime has, of course, been used for ordinary construction from time immemorial. Sir Arthur Cotton used lime mortar only, or lime-surki mortar, even for his most important works; and for years afterwards the use of lime mortar remained unchanged, for Portland cement did not become general in India till the seventies. The great Godavari and Kistna Anicuts had no Portland cement in them originally, and these achievements will ever remain as standing memorials to the genius of Cotton and Orr. Gradually, however, Portland cement crept in, at first for use in wet foundations only, in respect to which it showed marked superiority to lime-surki mortar, which was the thin edge of the wedge in extending its use to work above water, and thus extravagantly adapting it to a purpose for which magnesia, a cheaper and stronger material, would have been preferable. Yet Portland cement is undoubtedly a boon. It gives a feeling of security, particularly in these days of reinforced concrete bridges and high masonry dams, which make tensile strength and resistance to crushing, matters of greater importance than they were formerly. The high dam for the water supply of New York has been built in with Portland cement throughout. But it will, it is believed, have cost forty millions sterling, and that in a country where the manufacture of the material is an indigenous industry. Nevertheless, it may be economically right to use Portland cement for certain purposes, in preference to magnesia in a country where the former is made, and if a satisfactory brand of Portland cement is now being, or can be manufactured in India—a brand good enough to pass the requisite tests—the use of it may fittingly receive encouragement for such purposes. But when Portland cement has to be imported over a distance of several thousands of miles, it behoves us to consider whether it is really necessary to use this expensive material as an all-round mortar, where special strength is required, instead of restricting its province to works for which a magnesia cement cannot be shown to be equally suitable.

On the other side, it may possibly be contended that India has no cause to complain; for India Office statistics show the amount of annual importations to be small. For example, in 1909–1910 and 1910–1911 there were respectively only 12,999 and 8,588 tons of Portland cement imported through the India Office, for the whole of India; and of these quantities only 915 and 40 tons respectively were taken for the Madras Presidency. But it is impossible that importations through the India Office stores can convey the slightest idea of the quantity of cement that finds its way into the Indian markets for Government works alone. It is true that if materials of external manufacture are required by the Public Works Department they must be ordered through the India Office. In point of fact, however, it is frequently impracticable to adhere to this rule; and when materials are wanted at short notice, as is often the case, it is customary with Provincial Governments to exercise their right of sanctioning purchases from local suppliers. Thus, the India Office returns give no indication of the actual quantities of cement imported from the United Kingdom. Nevertheless, the quantities must be larger than would be the case if the merits of magnesia were duly appreciated.

Dunite.

Magnesia is the calcined product of the mineral magnesite, which is derived from serpentine, while serpentine is derived from dunite—so called from the Dun Mountain of New Zealand—and dunite is a composition of olivine and chromite. The bulk of the rock of the chalk hills is dunite with intrusions of magnesite, comprising from a tenth to, in some places, as much as a half of the whole.

Mr. Middlemiss quotes the following analysis

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of a specimen of dunite, as made in the Calcutta Geological Laboratory by Mr. Blyth:—

	Per cent.
Silica	39·10
Magnesia	48·26
Iron and aluminium, Manganese, Chromium, Moisture, etc.	12·64
	100·00

Specific gravity, 3·176.

Dunite from the Dun Mountain has been analysed by von Hochstetter to contain:—

	Per cent.
Silica	42·80
Magnesia	47·38
Ferrous oxide (after the chromite has been removed)	9·40
	99·58

And an analysis of oriental olivine, taken by Mr. Middlemiss from Dana's "Mineralogy," is as follows:—

	Per cent.
Silica	39·73
Magnesia	50·13
Ferrous oxide	9·19
	99·05

Specific gravity, 3·351.

Dunite we may practically assume to contain about 41 per cent. of silica and about 48 per cent. of magnesia, which, owing to the excessive proportion of silica, is a useless combination for a cement, as has been shown by experiments made last year by Mr. T. Bolas, F.C.S., F.I.C. But dunite and low grade, highly silicious magnesia—both of which had been calcined and ground separately, and afterwards mixed together with sand and water, but no magnesium chloride—attained, as a cement, a tensile strength of 201 lbs. per square inch and a compressive resistance of 2,290 lbs. per square inch, seven days after moulding; and this specimen was stated by the same chemist to have been distinctly hydraulic in setting. In the light of such a result further experiments with these materials are considered necessary.

Mr. Middlemiss has no doubt that the whole of the areas consisted originally of dunite, the olivine constituent of which passed into serpentine, while the chromite became segregated into nodules and veins. As serpentine is always produced by a chemical change in another mineral or rock, Mr. Middlemiss is undoubtedly right in his surmise. However, serpentine in its common form is too poor in magnesia, and too abundant in silica to be of use as a cement until it attains the form of magnesite, into which it is developed in the process of time.

The present supply of the magnesite is comprised in hillocks, which rise to a height of some 30 ft. above the level of the plain; and recent measurements show the existence in those hillocks of possibly a million tons of crude magnesite mineral, which might be quarried in open cut and thus taken out without mining. This would provide an output of 25,000 tons crude, or 10,000 tons calcined magnesia per annum for forty years, after which mining operations may be necessary, but nothing is yet known as to the persistence of these magnesite deposits in depth.

The Two Classes of Magnesite.

There are two important classes into which this magnesite is graded:—

(1) The second grade, containing from 80 to 90 per cent. of magnesium carbonate, and from 10 to 11 per cent. of silica.

(2) The first grade, containing over 90 per cent. of magnesium carbonate and about 1½ per cent. of silica.

Uses of Magnesite.

The uses of magnesite can be considered under the following heads:—

(*a*) Crude.
(*b*) Caustic, or lightly calcined.
(*c*) Dead-burnt.
(*d*) Fused.

CRUDE MAGNESITE.

At present there are but few direct uses for the crude magnesite; but its use as a source of carbon dioxide (CO_2)—a by-product in the manufacture of a calcined product—may be mentioned. Also the crude material may be cited as a convenient source of certain magnesium salts, of which the sulphate of magnesia (Epsom salts) may be taken as an example. It is further used for filling purposes, as in cotton goods, rubber, and paper, for which there may be a field in India. Crude magnesite has, after grinding, also been found suitable for use as a manure.

CAUSTIC OR LIGHTLY CALCINED MAGNESIA.

The caustic magnesia is produced by burning magnesite at a temperature of from 700° to 900°C. The magnesite may be either pure or moderately silicious; and it may, after calcination—in gas-fired shaft kilns and also in bottle kilns—be mixed with magnesium chloride in solution, and from ten to twenty parts of sand, by which process it becomes formed into a cement as hard as sandstone, and is rendered adaptable to various purposes, of which the following may be

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mentioned: Plasterings, the manufacture of artificial stone, sand-bricks, slabs, tiles, concrete, magnesian mortar for magnesian bricks—though in that case not more than two or three volumes of sand should be used—woodstone floorings, sinks or gullies, tubes, receptacles for liquids, mantelpieces, garden furniture, and the manufacture of decorative and various moulded objects.

Magnesium Chloride ($MgCl_2$).

The preparation of magnesia cements of the Sorel type involves an admixture of magnesium chloride. Sorel, the originator of oxychloride cements, mixed the oxide and chloride of zinc together before he discovered the superiority of oxide-cum-chloride of magnesium.

Manufacture of Sorel Cement.

The object of mixing magnesium chloride with magnesia (MgO) is to impart to the combination high cementitious properties. The process of manufacture of the cement is as follows: The crude magnesite, either pure or laden with a certain quantity of silica and alumina, is first calcined in a gas-fired kiln, at a temperature up to 900° C. The lightly calcined or caustic magnesia, whose carbon dioxide has been partly driven off, is ground in a mill to the utmost attainable fineness; and a solution of magnesium chloride, together with an admixture of sand, is commingled with the finely-ground and lightly-calcined product in certain variable proportions. Of these, four parts by weight of the chloride ($MgCl_2$ 33 per cent.) solution, and fifty parts by weight of sand to five parts of magnesia may be taken as a typical example. It is important that no water other than that of the solution be used, as a rule, and in all cases the use of superfluous water should be avoided.

The mass commences to set at once, can generally be handled in under twenty-four hours, and in about a week is fit for testing.

Magnesium chloride required for use in India can be obtained thus:—

(*a*) It may be manufactured by adding burnt magnesite, or burnt dolomite, to calcium chloride, and the mixture is then treated with carbonic acid—a waste product of the industry—which causes the calcium carbonate to separate, and the magnesium chloride to remain in solution. This is the method adopted by Lanquetin, of Paris.

(*b*) The chloride can be imported in water-tight vessels from Stassfurt, where it occurs in the saline beds.

(*c*) It is obtainable in India itself from the bitterns, or sea-water residue, after the salt ($NaCl$) has been abstracted by crystallisation.

Imported Magnesium Chloride.

In ordering a consignment of magnesium chloride, precautions should be taken to secure a reasonably pure material; and estimates may be based on the assumption that one ton of a pure, anhydrous chloride dissolved in two tons of water will give a solution to be incorporated with the oxide—which may contain, after calcination, up to 20 per cent. of silica—in the ratio of four to five. On the other hand, it may be taken as certain that the magnesium chloride will be not quite anhydrous. It is indeed possible that crystals containing half their weight in water may be substituted for pure chloride; in which case the amount of water to be added for a solution will have to be reduced.

But it would be obviously extravagant to accept crystals that contain much water, and to pay for them and their carriage at the price of anhydrous chloride.

Scherer refers to the dehydrating process of the new Stassfurt Company, by which the water can be reduced to 12 per cent.; and he also refers to another industrial process, which gives an almost entirely anhydrous chloride. Thus, it would be possible to take necessary precautions in the matter.

Cost of Magnesium Chloride.

It is computed that European commercial magnesium chloride can be delivered at Salem at a *pro forma* quotation of £5 a ton; and, on the basis of a 33 per cent. solution, one ton of this chloride would, after delivery, have to be mixed with two tons of water; and thus, allowing a little for labour, a ton of that mixture might cost about £1 16*s*. Four-fifths of a ton—the proportion to be mixed with one ton of magnesia—would cost, say, £1 9*s*.; and, therefore, £1 9*s*. would be the sum to be added to the price of a ton of magnesia, if the plan of buying commercial chloride be adopted.

Sale of Magnesium Chloride by the Salt Department.

But it is hoped that the purchase of commercial chloride may be avoided, so far as the Government is concerned; for, in the event of magnesium chloride being obtained from the bitterns, the Salt Department might, by extending the salt industry to the development of magnesium chloride as a by-product, very reasonably derive a profit by selling the bitterns to the users of the cement.

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The manufacture of salt in India is entirely a monopoly of the Government, who derive a large revenue from its excise. They possess along the coast of Madras factories where salt is extracted from the sea-water, and magnesium chloride might be obtained from these factories.

The sea-water is run into so-called pans—that is to say, shallow beds, where the water is evaporated by solar heat; thus the salt crystallises out, and leaves a residuum named bitterns. The salt is then collected, but the bitterns remain as a hitherto neglected product. Yet precautions have to be taken to prevent this waste product from passing into the hands of people who might glean salt from it, and so prejudice the public revenue. Under these, or, if necessary, additional preventive arrangements, it would be possible for the Government to dispose of the bitterns to the magnesia cement industry, stimulating thereby local trade in magnesia cement, which may assume large proportions.

With the co-operation of the Government of Madras, a practical experiment in the extraction of magnesium chloride from bitterns could be conducted at one of the salt factories in the south of the Presidency, where there is a maximum of heat and a minimum of rainfall. And a suitable place, where there is a salt factory, would be Vedarnien, south of Negapatam, for the site there is drier and hotter than elsewhere, while the rain is scanty and easy to avoid.

Bitterns.

With respect to extracting salt from the Madras bitterns, Dr. Ratton says that the manufacture of salt ceases when the hydrometer marks 32° Baumé, and the bitterns become practically a saturated solution of magnesium chloride; thus that is the stage at which the product should be used.

Although investigation as to the requisite strength may not have hitherto received such attention as is desirable, it is known that bitterns which register 32° Baumé consist of a nearly saturated solution, whose strength is 27 per cent. of magnesium chloride, for when this strength is reached there is only some 2 per cent. of sodium chloride remaining in solution.

Mr. Bolas has experimented with a 33 per cent. $MgCl_2$ solution, which contains one part by weight of anhydrous magnesium chloride to two parts of water, without losing its slightly pasty nature. This may be due either to a deposit of hydrated magnesium chloride in a crystalline or semi-crystalline form, or to the separation of an oxychloride of magnesium.

In dealing with bitterns it should be borne in mind that magnesium is not the only metal of which they may contain the chloride. It is naturally the business of the Salt Department to see that there is a minimum of sodium chloride left in the pans; and, since brine containing 27 per cent. of magnesium chloride does not hold in solution more than 2 per cent. of salt, and there appears little or no room for calcium chloride ($CaCl_2$), the inference may be deduced that such brine is virtually a solution of $MgCl_2$, but this is a matter which may require further elucidation.

However, if this surmise should be proved correct, it would be a point in favour of the Madras bitterns, for elsewhere there are bitterns which hold as much chloride of calcium as they do of magnesium. Fürer, in his "Salz-bergbau und Salinkunde," rather emphasises the presence of calcium chloride, which may sometimes be mistaken for magnesium chloride—a point to be considered in examining bitterns, since calcium chloride is apt to exercise unfavourable action as a retarding agent, but its real influence, whether for good or ill, is a question to be determined by further experiment.

Alternative Methods of Using $MgCl_2$.

The magnesium chloride can either be used in the form of a bitterns solution, or the water may be removed and the residual chloride transported separately to the work spot.

Cost of Magnesium Cement Compared with that of Imported Portland Cement.

As shown above, £1 9*s*., the price on a *pro forma* quotation of a one-third ton $MgCl_2$ admixture, may have to be added to the price of a ton of magnesia, which may be taken at £4—ground—on trucks at Salem. Nevertheless, the oxychloride, with its superior carrying capacity, is cheaper than Portland cement when used as a mortar.

A ton-and-a-third of magnesia cement would cost a purchaser £1 9*s*. plus £4, i.e., £5 9*s*., or at the rate of £4 1*s*. 9*d*. per ton, inclusive of fine grinding and packing the magnesia into bags, in which it will be kept separately until it has to be made into mortar. Then, after mixing the magnesium chloride solution with magnesia and sand in the necessary proportions, and also after mixing the Portland cement with sand and water in their necessary proportions, and

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completing the mortar-making process, we obtain the following comparison :—

A strong magnesium oxychloride cement, containing ten parts by weight of sand to one part of fine-ground silicious magnesia and four-fifths of a part of $MgCl_2$ 33 per cent. solution, whose tensile strength was 269 lbs. per square inch after five days (Bolas), costs about 11*s.* per ton at Salem, inclusive of grinding and packing.

A strong Portland cement mortar, containing three parts by weight of sand to one part of cement, and having a tensile strength of 250 lbs. per square inch after twenty-eight days (British Standard Specification), costs about 16*s.* per ton at Salem. And it is observed that the proportions mentioned for the magnesia cement virtually correspond to those employed for the manufacture of artificial stone at Boston, U.S.A., which has been proved to be unaffected by any kind of climatic influence.

The proportions of cement to sand given for the Portland cement mortar are those mentioned by the Expanded Metal Company for armoured concrete. But such proportions remain fairly constant, even if the mortar be used for a wall plaster; whereas, if a magnesium oxychloride cement be used as a wall plaster, twenty parts of sand may be mixed with one part of magnesia which will considerably reduce the price of that cement. In fact, it might lower it to 6*s.* 6*d.* a ton, inclusive of fine grinding and packing into bags.

Last summer, in the course of experiments with magnesia, attempts were made to obtain a good cement by substituting various agglomerants for chloride of magnesium, such as borax with water, calcium chloride, sulphate of aluminium paste, sugar and water—some of the mixtures steamed and others unsteamed—and stirring up with each sample an admixture of ten parts of sand to one part of magnesia before moulding the whole into a disc; but the samples were all easily snapped with the fingers when tried, as was also a mixture of magnesia, sand, and iron perchloride (Fe_2Cl_6, 60 per cent. solution) weighed in the proportions of 5, 20, and 4 respectively, which had been eight days immersed in water. Yet it happened that a steamed sample, consisting merely of magnesia, water, and sand, could not be snapped until after a ten days' immersion. The caustic magnesia with which the experiments were made had been very finely ground in every case; and the apparent superiority of magnesia unassociated with any cementitious agent over magnesia more favourably placed must have been due to the steaming operation.

Crushing Resistance of Caustic Magnesian Mixtures.

In contrast to these failures, particulars of other types of magnesia cements, as given in the table on p. 857 are interesting, in that the cements display their powers of resistance to crushing after certain specified periods of immersion, periods that were continuous except for a few hours on February 24th, when the samples were taken out to be examined. These consisted of discs each 28 mm. in diameter and of the different thicknesses noted.

The magnesia with which the experiments were made was of two grades, one a moderately —MgO in the table—and the other a highly silicious grade. And both classes were the lightly calcined products of crude magnesite from Salem. In the former of these the original magnesite held 5 per cent., and in the latter 10·7 per cent. of silica. After burning, and the consequent expulsion of carbon dioxide, the proportions of silica left in the resultant magnesia will have been about doubled.

As against the greater purity of the 5 per cent. of silica grade of magnesite, the grinding of its product was not so fine as the grinding of the 10·7 per cent. grade.

Experiments with Dunite as an Admixture.

The dunite used was from Salem, and it was calcined at a temperature of from 700° to 800° C. Two samples of this dunite-cum-magnesia were moulded, one of which, not in the table, gave a tensile and crushing strength of 201 lbs. and 2,290 lbs. to the square inch in seven days, as previously noted. This sample consisted of 6 grammes of low calcined silicious magnesite, 6 grammes of low calcined dunite, 36 grammes of white sand, and 4 grammes of water, while the object of the experiment was to ascertain whether calcined dunite could serve as the "acid," or non-calcareous element in a cement.

The other sample is described in the table on p. 857, item No. (15). The sand used was fine "silver" sand in all cases. The silica and the alumina were pure laboratory products. And the perchloride of iron was the ordinary commercial product.

It will be seen that the oxychloride sand cements gave very good results only when agglomerants such as silica, alumina, or dunite were added. But the clay mixtures—items (12) and (13)—which contained no chloride, are, with

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No.	Thickness of Disc. [illegible] Millimetres.	Sand. Grammes.	MgO. Grammes.	Highly Silicious MgO. Grammes.	$MgCl_2$ 33% solution. Grammes.	Silica (hydrated). Grammes.	Alumina. Grammes.	Clay. Grammes.	Dunite. Grammes.	Fe_2Cl_6 60% solution. Grammes.	Water. Grammes.	Date of manufacture.	Date of immersion.	Crushing resistance on March 14th, 1912. Lbs. to square inch.	Number of days immersed previous to crushing. Only the three specimens noted could be snapped with the fingers.
(1)	4·5	20	5	..	4	..	..	..	..	..	..	May 27, 1911	Feb. 7, 1912	3,360	Snapped after 12 days
(2)	6·5	20	5	..	4	1	..	..	..	..	..	" " "	" " "	3,910	34
(3)	7	20	5	..	4	1	1	..	..	..	..	" " "	" " "	4,340	34
(4)	7·5	20	5	..	..	..	..	..	..	4	..	May 30, 1911	Jan. 29, 1912	2,930	Snapped after 12 days
(5)	6	20	..	5	4	..	..	..	..	..	..	June 2, 1911	Feb. 17, 1912	3,310	24
(6)	5·5	40	..	5	4	..	..	..	..	..	4	" " "	" " "	2,660	Snapped after 2 days
(7)	7	40	..	5	4	..	..	..	..	..	..	" " "	" " "	3,250	24
(8)	8	40	..	5	4	..	..	..	..	..	..	" " "	Feb. 7, 1912	2,900	34
(9)	10	75	..	5	4	..	..	..	..	..	..	June 7, 1911	Feb. 17, 1912	2,060	24
(10)	11	20	..	5	4	..	..	..	..	..	..	" " "	" " "	1,970	24
(11)	8·5	24	..	6	..	..	..	..	..	..	4	June 16, 1911	Feb. 7, 1912	2,490	34
(12)	7·5	24	..	6	..	..	..	3	..	..	4	" " "	" " "	4,130	34
(13)	8	24	..	6	..	..	..	3	..	..	4	June 24, 1911	Feb. 8, 1912	3,910	33
(14)	6·5	24	..	..	..	9 "cement"		..	..	..	4	" " "	Feb. 7, 1912	3,060	34
(15)	7	32	..	1/6th of mass	4	..	..	..	8	..	..	Aug. 22, 1911	Feb. 17, 1912	3,940	24
(16)	12·5	50	..	5	4	..	..	..	..	..	..	Oct. 13, 1911	Jan. 29, 1912	2,850	43

The samples were prepared and the crushing tests applied by Mr. Bolas.

their crushing resistances of 4,130 and 3,910 lbs. per square inch, comparable to pure Portland cement, and they are superior to Portland with an equal part of sand in association therewith.

Crushing Resistances of Portland Cement.

The following comparison is taken from Hurst's handbook, reducing crushing resistances in tons per square foot to pounds per square inch:—

	Lbs. per square inch.
Portland cement, pure, 3 months' old	2,364
„ „ and sand in equal parts, 3 months' old	1,555
„ „ „ „ 1 to 4, 3 months' old	1,120
„ „ pure, 9 months' old	3,733
„ „ and sand in equal parts, 9 months' old	2,815

The clay and the magnesia were in extremely fine powder—so fine, in fact, that the bulk of the particles did not exceed $\frac{1}{3000}$th of an inch in diameter, and the materials were rubbed together in a mortar; after which the sand, and then the water, were added and well incorporated with the other materials. The slightly damp products were finally malleted into circular steel moulds 28 mm. in diameter; and such was the general procedure adopted in the manufacture of all the other specimens.

However, tests with small pieces are certainly not so satisfactory as would be tests with larger blocks, which were presumably used for the Portland cement samples just quoted. Yet the margin between the magnesia-clay-sand mixtures and the Portland-sand-cements being so large, it is conceivable that even under parallel conditions the results would still be in favour of the former. But this is a matter for elucidation by further experiments, and these are now in progress. The methods adopted for carrying out the experiments under notice were similar to what is usual—that is to say, small stones (or coarse sand) were run down into a receptacle until the sample operated on was crushed under a system of levers.

In order that the tests might be as thorough as possible, the discs—as regards both oxychlorides and clay mixtures—were fashioned approximately into cubes, whose indicated resistances represent tests of single pieces, and not averages of a number of tests.

Clay Mixtures Compared with Oxychlorides.

On comparing the clay mixtures with the oxychlorides, or Sorel cements, it may be observed that, although the former did not carry as much sand as the oxychlorides, no such cementitious agent as chloride of magnesium was requisitioned to assist in their hardening; and a cement that can dispense with this important adjunct, while giving such a satisfactory result, is one of the highest importance.

Combinations (12) and (13), though apparently identical, differed with respect to the calcination of their clays. Of these the clay of the first item, which showed the greater strength, had been burned at a temperature of 200°, and that of the other at a temperature of 600°. The period of calcination was fifteen minutes in each case.

After twenty-four hours, sample (12) was immersed in water, where it remained till June 24th, 1911, or eight days; thus, its immersion in the following February and March was its second experience of water.

The Public Works Department might lay down a finely-ground magnesia-clay mixture as a mortar for concrete in foundations for some comparatively unimportant work, in the first instance, such as an irrigation distributary sluice or a road culvert. If the foundations were laid in a dry trench, which can often be done by means of a diversion cut, and kept dry for a week or ten days after completion, the water might then be turned on and allowed to cover them for a month, when it could be seen how they had stood the test.

Unlike the clay mixtures, the more quickly-setting oxychloride cements showed a tendency to soften in water; and, excellent as these oxychlorides are for work not under water, it is not, in the light of our recent experiments, considered desirable to subject such cements to the liability of absolute submersion, unless they can be periodically exposed to the air, so as to give them a chance of regaining their original hardness, which they do, as is apparent from the present state of the crushed specimens of our experiments, the pieces of which have become very hard.

It has been stated by various experts that magnesia cement is without hydraulicity; and such must necessarily be the case if the oxide be pure, or uncombined with a high percentage of active silica, for no cement that has less than 10 per cent. of silica, or an equivalent, in its composition will set under water. Messrs. Stanger and Blount say that magnesia cement is

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merely hydraulic, inasmuch as when in water it does not disintegrate and crumble to pieces, but that it is not hydraulic in the sense in which the term is generally understood when applied to cements, for it is found that when magnesia cement—presumably after it is hardened—be immersed for any length of time it gradually decreases in strength until at the end of a period of twenty-eight days' immersion a briquette of one square inch section can be easily snapped between the fingers. As regards the last assertion, it is hereby contended that if very finely-ground magnesia be mixed with magnesium chloride and sand in suitable proportions, no ordinary man could snap a briquette—other than a dumb-bell shaped one—one square inch in section with his fingers. He might as well try to snap a piece of flint. The same authorities appropriately allude to the excellence of magnesia cement as a plaster, and to its capability of withstanding climatic changes, while they quote the well-known instance of a piece of magnesia plaster that had been applied to a building in Madras, where "it withstood the action of three monsoons and two hot weathers, and when last examined had not shown the slightest sign of being adversely affected, and was infinitely harder and more adhesive than the very best Portland cement plaster."

They then proceed to state that magnesia does not combine with the silicates of iron and alumina to form a hydraulic cement in the manner in which lime does. Here Messrs. Stanger and Blount would seem to be at variance with Redgrave, who claims, in his "Calcareous Cements," that the silicate and aluminate of magnesia produce a hydraulic cement which possess the same properties as, but is much stronger than, the corresponding lime compounds. And our experiments with the clay mixtures have a strong tendency to confirm this opinion. In fact, our series of experiments shows silicious magnesia to combine more strongly with clay than it does with magnesium chloride by itself; and if we knew more about magnesia-clay cements, it is possible that we might prefer them to the oxychlorides for all purposes, since clay is more easily obtainable than chloride. However, in the present state of our knowledge, it may be desirable to confine ourselves to oxychlorides for aërial work.

The Class of Magnesite to Choose.

With regard to selecting the magnesite, a consumer may argue that as ninety-five parts of magnesia will carry more sand than will eighty-five parts of the same, the best value is obtained by buying the purest grade possible; and if magnesia be the unit of purchase he is right. On the other hand, it should be remembered that reactable silica would appear to have a tendency to protect magnesium chloride against the effect of moisture, to which all works are subject. The highly silicious dunite admixture, item (15) in the table, should get much of the credit for the 3,940 lbs. per square inch compressive strength which was attained in that case. Again, the agglomerants hydrated silica, item (2) on the list, and hydrated silica plus alumina, item (3), caused the mixtures concerned to attain a crushing resistance of 3,910 lbs. and 4,340 lbs. to the square inch respectively.

It should be borne in mind that the amount of water used in a solution of magnesium chloride is important, for the water enters into combination, while the chloride merely assists the reaction; thus whether the magnesia be moderately pure, as in item (4), or strongly silicious, as in item (10)—to take two samples of equal mixtures—although the cement may be hard set, any water in which it may be immersed will extract some of the chloride and soften the cement. To obviate this disadvantage the Germans mix precipitated silica with the magnesia, as in item (2), in the proportion of 15 per cent. for choice; and they preserve the hydraulic properties of the cement by moistening it with a solution of magnesium chloride, while the hydrated or precipitated silica serves as a guard against disintegration by the action of water.

Resistance to Sea Water.

Scherer mentions that a cement so treated binds in about ten hours, and forms an exceedingly hard mass, which resists sea water; and he recommends as the best proportions for this cement 100 parts magnesium oxide, 15 parts precipitated silica, and 90 parts magnesium chloride solution (80 per cent. $MgCl_2$). He must mean 80 per cent. solution of the crystals. But he insists that the ingredients must be most intimately mixed, and the magnesia be absolutely free from carbonic acid. He quotes the tensile strength of this cement at 1,300 lbs. per square inch, which is by no means incredible, and it would take a large multiple of sand to reduce it in strength to Portland type.

Surki.

The tendency which the wash of water on the magnesium chloride has to militate against true hydraulicity, or the power of setting under

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water *ab initio*, has a parallel in surki mortar. Surki, it may be observed, is powdered brick; and a mortar made up of equal parts, or otherwise, of surki, lime, and sand, being hydraulic, is largely used for wet foundations in India. But as water rises in the trench it drives out a great deal of the lime, which is consequently lost; it is accordingly desirable to lay the bottom six inches of concrete stones dry—that is, unmixed with mortar—as a base for the concrete-in-mortar foundation, and the experiments under review encourage the belief that, though a magnesia-clay mixture might be suitable to the situation, an oxychloride would be out of place except in combination with precipitated silica, either alone or in association with alumina, though possibly an admixture of dunite, as in item (15), might be substituted with advantage.

For anything short of a protracted immersion, nothing but sand need be added to the MgO and $MgCl_2$ solution, unless it be for something which has to be specially tough. In this connection Weber contends that agglomerates are, as a rule, tougher than unadulterated cements, for which reason he recommends what Scherer calls the MgOSiOMgCl for the manufacture of emery wheels—already mentioned—millstones, and artificial stone — ornamental and otherwise—which, moreover, forms an important industry in America, where they observe the following formula by Dr. C. T. Jackson, State Assayer of Massachusetts. This Eckel quotes as being suitable for window-caps, sills, steps, etc.:—

100 lbs.	of beach sand.
10 lbs.	of comminuted marble.
10 lbs.	of oxide of magnesium.
10 lbs.	of chloride of magnesium in solution (20° Baumé).
Total 130 lbs.,	yielding one cubic foot of moulded stone.

And Dr. Jackson adds, "For foundations and other plain, massive walls, the proportion of cement may be very considerably reduced, and the quantity of cobblestones increased"; which may be taken as evidence of the applicability of magnesia cement to concrete.

Lightly Calcined Magnesia in "Petrifite."

In the last decade of the nineteenth century a patent was obtained for a cement called "Petrifite," the composition of which consisted of nothing materially new. The cement was, in fact, just an oxychloride of magnesium with an admixture of acetate of lead; but the acetate of lead does not appear to have materially affected the main combination.

However, certain experiments made in 1897 by Messrs. David Kirkaldy & Son, as official tests for the Board of Trade and various railway companies, are instructive, in that they emphasise the superiority of magnesia cement. In giving the following particulars it should be noted that the specimens were cast without pressure:—

	Crushing resistance. Lbs. per square inch.
1 part of petrifite to 10 parts of sea sand, 30 days' old	3,405
1 „ „ 4 „ „ 30 „	9,000
1 „ „ 4 „ „ 10 „	8,095
1 „ Portland cement to 4 parts of sea sand, 10 days' old	734

It will be observed that the oxychloride of magnesium mixed with four parts of sand had practically attained its maximum compressive strength in ten days; and it may be mentioned that its tensile strength was correspondingly high, viz., 838 lbs. to the square inch in the same time, while that of the Portland was only 156 lbs.; and although the latter, being slower setting than the magnesian, will have continued to harden afterwards, the insignificant resistance to crushing which it showed must necessarily place it out of comparison with the oxychloride.

These experiments were made with sea sand. With three parts of pit sand to one part of the magnesia cement (presumably by weight), the resultant mortar showed a tensile strength of 946 lbs. per square inch, and the Portland cement mortar—mixed in the same proportions—one of 156 lbs., as in the former case; but the period was apparently seven days.

By substituting half a part of powdered chalk for half a part of sand the tensile strength of the petrifite mortar mounted to 1,217 lbs. in ten days.

As regards resistance to crushing, the one to three magnesian mortar, in combination with 8 per cent. of water, had a strength of 8,320 lbs.; and the one to three Portland cement mortar, in combination with 13 per cent. of water, had a strength of 635 lbs. But the period was probably ten days, which would suffice for the complete setting of a magnesium oxychloride cement, though not for a Portland.

To take one more example of an experiment with petrifite. Mr. T. J. Scoone, M.Inst.C.E., found that this material, made in a liquid form and mixed with other materials and placed under

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water, would set quickly. He found that a small briquette became hard in three days, and that in seven days it became strong enough to test. This hydraulicity in magnesium oxychloride must have occurred in chemical association with silica, or the cement would not have set under water. If the magnesium oxide of the petrifite was pure the "other materials" must have included silica in a reactable form.

For works not subject to protracted inundation it is of little importance whether the oxide be pure, or silicious within limits. Either, in union with magnesium chloride, would be vastly superior to Portland cement. But for works under water, the latter will continue to hold its own unless further experiments establish the pre-eminence of magnesian-clay, or some other compound.

In considering construction, however, we exclude works which do not need a specially strong cement as a binder; for lime and surki are admirably adapted to ordinary building requirements. Moreover, these commodities are cheap, and deserve encouragement as indigenous products. But imported Portland cement is neither cheap nor indigenous, nor is there any reason to prefer it as a plaster, for instance, to magnesium oxychloride, a much cheaper cement for the same strength, or a much stronger one for the same price, according to the proportion of sand mixed with it. Furthermore, Portland, in common with magnesian and other cements, varies in quality; yet an importation through the India Office is reliable, for it will have been tested according to the British standard specification, and tensile strains have been found by the Director-General of Stores to vary thus:—

Neat cement . .	At 7 days.	450–650 lbs.
	At 28 days.	Up to 950 lbs.
(Average, about 500 and 650 lbs. respectively.)		
Sand and cement	At 7 days.	150–250 lbs.
	At 28 days.	250–400 lbs.
(Average, about 200 and 280 lbs. respectively.)		

Ferro-Concrete.

Such are the brands used for reinforced concrete, whose requirements are so exacting that attention might well be turned to the still more powerful local material, magnesia; but experiment is necessary to determine whether chloride of magnesium would injure the steel framework by chemical action. This might be done by the Public Works Department with a beam of magnesium oxychloride-cum-sand, and the internal steel-work protected by a coating of some anti-corrosive paint; such, for example, as might be made, according to Scherer, by adding mineral oil and 10 per cent. of caustic magnesia to the ordinary linseed oil paint, the idea being that the metal will be protected from rust by the neutralisation of the free acids of the paint.

Ligno-Concrete.

The merits of magnesium oxychloride as a cement for ligno-concrete work might also be tested with advantage. Mr. Gerald O. Case has, in a paper read before the Society of Engineers this year, drawn attention to the efficiency of timber as a reinforcing material, in respect to which it is sometimes used in America and Australia in preference to steel.

Carborundum as an Admixture to Oxychloride.

It may be desirable to use the precipitated silica admixture for armoured concrete. Such an admixture to magnesium chloride is, as mentioned above, recommended by Weber for the manufacture of emery wheels; and experiments made by Mr. Bolas in 1911 show the absolute suitability for emery wheels of a naturally silicious caustic magnesia—even with no precipitated silica—in association with carborundum, instead of sand or emery. The proportions in that case were:—

Powdered carborundum, which had passed through a sieve of 80 meshes to the linear inch	50 grammes.
Silicious magnesia, containing about 20 per cent. SiO_2, lightly calcined at 700°–900° C.	10 "
Magnesium chloride, 33 per cent. solution	8 "

The magnesite was calcined for an hour in the laboratory, crushed in a mortar, ground for an hour and a half in a Carr edge-runner mill, and thus brought into a condition fine enough to pass through a 240-mesh gauze, by which process the bulk of the particles became reduced to the diameter of $\frac{1}{3000}$ths of an inch.

The carborundum, was first mixed with the magnesia and rubbed in the mortar, after which the chloride of magnesium was added, the mixture well stirred, and finally malleted into moulds. Eight days later a specimen block of the agglomeration was hard enough to cut into glass, and it cut into quartz almost as easily as into glass.

By substituting sandstone, or flint, for carborundum, grindstones can be similarly manufactured; as can also millstones by using scrap, or the broken pieces of discarded millstones, for the purpose. Of course, the magnesite would be burned in a kiln, and a

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period of twenty-four hours at a low heat might be necessary, for the reactable property of silicious magnesia is liable to be impaired by great heat.

Coal Briquettes.

The same proportions of the constituents of oxychloride cement, namely, ten parts by weight of silicious magnesia and eight parts by weight of $MgCl_2$ solution, will bind 200 parts by weight of small coal into briquettes, for which purpose caustic magnesia is, in virtue of its cohesion and elasticity, occasionally used, while the briquettes made through the agency of this cheap inorganic binder are remarkably solid, and thus suited to transport over long distances.

Xylolith, or Woodstone.

One more example of the use of lightly-calcined magnesia may be noted; namely, xylolith, or woodstone, which consists of an admixture of a sawdust to a magnesium oxychloride cement, and makes an admirable flooring which is jointless, noiseless, and dustless, and, being easily cleansed, is thereby rendered suitable for hospitals, bath-rooms, kitchens, etc.

If the flooring is to be outside, asbestos may be substituted for sawdust, for organic fillings are not weather-proof, whereas mineral mixtures are entirely so.

Great Importance of Grinding Fine.

From what we have said on the subject of caustic magnesia, it will be surmised that great importance is attached to the fine-grinding of the magnesia, and also of any calcined clay that may be used in a composition. It is, in fact, possible that any failure which may have existed in former days on the part of the natives to appreciate the value of magnesia as a cement may have been due to their inability to grind the product to the requisite fineness.

In the laboratory, where we deal with small quantities, it is possible to grind magnesia fine enough to pass through a sieve of 240 meshes to the linear inch. A grain of such powder may be measured by means of a ruling on glass; and Mr. Bolas used a spiral ruling 3,000 to the inch, which he employed as a provisional standard, so that with a microscope a single grain might be seen lying between two concentric circles $\frac{1}{3000}$th of an inch apart.

It is worth noting that, owing to the "bridging" and "clinging" action of the magnesia on the sieve, the particles which pass through are, on the whole, very much smaller than the meshes themselves. As a suitable regulator Scherer mentions a sieve of seventy-six meshes to the linear inch, with an allowance of 3 per cent. residue on the sieve, and this corresponds to the British standard of fineness for Portland cement, while the same standard prescribes as an alternative a sieve with 180 meshes to the linear inch, and a limit of 18 per cent. residue on the sieve.

A Portland cement that compares with these technicalities is used for reinforced concrete, for which it is good enough, since—mixed with three volumes of sand—it will have a tensile strength of 250 lbs. to the square inch in twenty-eight days; while its specific gravity will comply with a requirement of 3·15 at works, or 3·10 after delivery to consumer.

This closes our observations on the caustic or lightly calcined material, as applicable to engineering works. But engineering is not its only field. It is, for instance, possible to make use of lightly-calcined magnesia in the manufacture of paper from wood-pulp. Again—and this may be urged as a further incentive to co-operation on the part of the State—magnesia may be used as a basis for important disinfectants and bacteriocide preparations—as, for example, the hypochlorite, a salt which possesses bleaching properties. Furthermore, its extension to the manufacture of magnesium peroxide might possibly be encouraged, for magnesium peroxide, under the designation of magnesium "perhydrol" is now used for various medico-sanitary purposes.

DEAD-BURNT MAGNESIA.

Although dead-burnt magnesia has not such a variety of uses as has the lightly calcined mineral, its importance may be considered in one respect as even greater than the latter, in that it is most difficult—if not impossible—to find an adequate substitute for dead-burnt magnesia in the composition of a work which is required to possess great refractoriness against heat.

In this connection it may be stated that when magnesia has to be dead-burned it is preferable to select it from the purest class.

And the following analysis by Mr. H. H. Dains, F.I.C., may be taken as typical of the first grade class of Salem magnesite:—

	Per cent.
Silica	0·29
Iron oxide, Alumina	0·65
Manganese oxide	0·20
Lime	0·83
Magnesium oxide	46·42
Carbon dioxide	50·71
i.e. Magnesium carbonate	(97·13)
Combined water	0·16
	99·26

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As a Lining for Basic Furnaces.

The selection of a pure class of magnesite is necessary when the magnesia is to be dead-burned, because the product will be required as a lining for basic furnaces, or for the manufacture of fire-bricks, both of which necessitate a highly refractory material; and the refractoriness of magnesite varies inversely with its percentage of silica.

Hitherto the use of dead-burnt magnesia has been practically confined to Europe and America, but now, thanks to the enterprise of Messrs. Tata, the demand is likely to arise in India as a lining for basic furnaces for the manufacture of steel, which are now in the course of erection at Kalimati.

Calcination of Magnesite for Dead-burnt Magnesia.

To obtain a ton of dead-burnt magnesia two tons of crude magnesite are theoretically required, on the assumption that the magnesium carbonate ($MgOCO_2$) consists of 50 per cent. magnesia (MgO) and 50 per cent. carbon dioxide (CO_2), each by weight, which is approximately correct. On calcining at a temperature of 1700° C. for a sufficient period, the carbon dioxide is expelled into the air, leaving the magnesia in a dead-burnt condition. But, in practice, it is necessary to use $2\frac{1}{2}$ tons of magnesite to produce one ton of magnesia, the extra half-ton being a provision to allow for loss one way and another. This shrunk magnesia has a specific gravity of 3·5.

Of course, as the magnesite does not actually hold 50 per cent. MgO and 50 per cent. CO_2, there must necessarily be a certain quantity of "impurities" deposited; and, as these tend to impair the refractoriness of the magnesia, the demand for the purest magnesite is persistent, especially as the impurities are not driven off, and are therefore practically double in the resulting product.

The undermentioned analysis of "Indian dead-burnt" calcined in a gas-fired kiln is by Mr. Dains:—

	Per cent.
Silica	4·38
Ferric oxide	1·02
Alumina	0·10
Lime	1·04
Magnesia	93·12
Loss on ignition	0·34
	100·00

It will be seen that a high percentage of magnesia is maintained, for the employment of a gas-fired kiln obviates such contamination as would occur with the ash if coke were the fuel.

Fire-bricks.

There is a demand in India for fire-bricks, which are always imported from Europe; whereas, with sufficient encouragement, the manufacture of fire-bricks might well be organised as an indigenous industry, since it is conceded that no bricks are so refractory as those of the magnesia class.

The following analysis is that of a fire-brick made from Indian magnesia:—

	Per cent.
Magnesium oxide	92·12
Iron peroxide	1·02
Alumina	0·10
Calcium oxide	1·04
Silica	4·38
Phosphates, sulphates and alkalies	traces
	98·66

This brick was made at Neath; but Mr. Dains quotes an analysis by J. W. Westmoreland, of a brick, likewise from Indian magnesia, which contained 93·94 per cent. of magnesia and only 2·60 per cent. of silica. Its specific gravity was 3·58.

MAGNESITE FUSED IN THE ELECTRIC ARC.

A more highly refractory magnesia may be obtained by calcining the magnesite in the electric arc at a temperature of about 3000° C., and maintaining a current of 3500 ampères at a pressure of 65 volts. This subject is fully dealt with in the "Transactions of the Faraday Society" for August, 1905, where it is noticed that Salem magnesite, which had been electrically calcined in Norway was, in conjunction with other magnesite products of Salem, awarded a gold medal at St. Louis, and highly commended by Mr. Edison as a refractory material of exceptional value. Another gold medal was awarded at the Franco-British Exhibition of 1908. Fused magnesia has a specific gravity of 3·58 (Dains).

Specific Gravity.

In dealing with the question of specific gravity, it may be noticed that the engineer determines the specific gravity of the mass, and the chemist that of the particles comprising the mass. Thus the specific gravity of a magnesian brick, reckoned at 2·5 by an engineer, would become 3·58 (Dains) under a chemist's manipulation. It was from the latter standpoint that Mr. Bolas obtained the

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following as the results of his experiments last summer:—

1. Lightly calcined silicious magnesian cement, consisting of: Crude silicious magnesite, holding 10·7 per cent. of silica, 140 grammes; flesh-coloured clay from Salem, 35 grammes; mixed and ground to nodules of about $\frac{1}{3000}$th of an inch across. Heated and subjected to air-pump action. Specific gravity, 3·46.

2. Silicious magnesite of the same kind, but with no clay. Subjected to the same treatment. Specific gravity, 3·33.

3. High-burned magnesia from an almost chemically pure magnesite. Specific gravity, 3·45, which approximates closely to the 3·50 specific gravity as given by Mr. Dains, for the same class, in his lecture at Burlington House on May 3rd, 1909.

Another example of this kind indicated a specific gravity of 3·32 only, the lowness of which figure may have been due to the action of the air on the sample, for a thin layer was formed on the bottom of a bottle in which it had remained for some weeks.

4. Lightly calcined magnesia (in fine powder of course). Specific gravity, 3·57, which is practically the same as 3·58, given by Mr. Dains for artificial periclase.

It is conjectured, from these experiments, that the specific gravity, that is the specific density, of magnesia, is subject to little real variation, and, thus, such variation as is apparent from the figures quoted may be due to difficulties encountered in obtaining absolutely accurate results. Therefore, in the case of magnesia, the specific gravity scarcely gives a ready or certain means of forming an opinion as to the cementitious condition of the material.

With Portland cement it is otherwise. There the sintering of the materials results in a heavy product, the specific gravity of which may be accepted as an index of its cementing power; and in a routine testing laboratory the precise specific gravity can be easily determined, whether it be 3·10 or 3·15, figures insisted on by the British Standard Specification as a minimum; and figures which would allow a large margin for magnesia, whose specific gravity is invariably higher than these; while the rapidity with which an oxychloride magnesian cement sets, and attains its tensile strength, would seem to emphasise its suitability for reinforced concrete and other forms of construction, always provided adequate measures be taken to protect contiguous iron or steel from any corrosive action that magnesium chloride may possibly exercise.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Conditioning Houses.—Upon the Continent there are at least eighteen public institutions to which textile materials may be sent in bulk for test and certification. There are nine in France, but in this country precision is less popular, and of fully equipped conditioning houses there is but one. Manchester has had its Chamber of Commerce testing-house since 1895, and its certificates are authoritative the world over, but this is a sample testing-station only. The single bulk conditioning-house is at Bradford, and is municipally owned. It has been at work for twenty-one years, and its premises are thoroughly outgrown and are being extended. The establishment was created to meet the demands of exporters, and only gradually have its services come into large use by parties to the home trade. Tests of many kinds are performed there, but tests for "condition," *i.e.*, moisture, form by far the main part of the work. In round terms the conditioning-house handles 100,000,000 lbs. of material annually, three-quarters of it being combed but unspun wool. It conducts nearly a quarter of a million tests a year. The method of testing for moisture is simple, and has been so organised that the ovens can be watched by girls. A pound sample is suspended from one arm of a balance, and hangs in an ascending current of air heated to 220° to 230° F. The loss of weight is noted, and when a constant level is reached the bone-dry weight is ascertained. To this result is added a standard allowance representing the normal regain, and the disparity between this and the observed loss gives the variation above or below correct condition. Cotton is credited with a regain normally of 8½ per cent., silk of 11 per cent., linen, 12 per cent., and wool 16 to 19 per cent., according to its state. These are percentages of the dry weight, and not to be confused with calculations on the gross weight. Wool of 19 per cent. regain is in correct condition when containing fractionally less than 16 per cent. of water. The allowances accord broadly with the common experience of the hygroscopicity of the several fibres, and are in international usage.

Motor-cars and Textiles.—The presentation of lengths of motor cloth to the King and Queen at Batley, gives a reminder of how textile industry is shaped by outside circumstances. The advent of the motor set in motion changes which most manufacturers have felt. Very early the taste for motoring began to destroy the fashion for elaboration in dress, so affecting some groups of mills adversely. Some amends were made by new demands for wind, weather and dust-proof garments, leading to the creation of new and various fabrics called by the name of motor cloths. Veiling assumed a new importance, and tweed caps became a necessity of motoring men. The old trade in horse-clothing has contracted, but a far from inconsiderable quantity of cloth is taken to equip

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the motor-car. The mock-leather seats are cotton dressed on one side with a paste of viscose derived from wood-pulp. Some manufacturers are busied with little else than making strong cotton duck for imbedding in tyres. Motorists grumble at some of the tyre-fabrics supplied, but the manufacture receives pains to make the cloth strong initially and to prevent deterioration from wet. As the 60 lbs. pressure within the tyre is more than some steel boilers can withstand, occasional bursts are not inexcusable. Cotton, linen, jute, and even camel-hair are used in hoods for cars, and the business in knee-flaps, rugs, and floor-coverings is rather more than negligible to-day. Thus far aviation has produced no comparable changes. There is a demand, small but growing, for wing fabrics for aeroplanes, and for the most part this is met by foreign-made, light and strong cloth, manufactured from long Egyptian cotton.

Camel Hair.—It may be feared that not all products sold under the name of camel hair owe their origin to the camel, although some 8½ million lbs. of the authentic hair are regularly imported into this country, and some 5 to 6 millions are retained. The manufacture is a minor branch of Bradford activities, and is in comparatively few hands. The hair serves two distinct sets of purposes. On the one hand there is the consumption of the short hair for making soft, warm hosiery, and fleecy linings or fine Wilton carpets. Again, there are demands best filled by the coarse beard hair from the thigh, throat, and humps. Camel hair, its blends or substitutes, is much used for making mats or cloths for oil presses, machine belting, and to a less extent for motor-car hoods and golf bags. Where durability is the first consideration, the supply of camel hair is eked out by the coarsest wool, human hair or any available long and strong fibre. The mixture is combed and brought to a fairly uniform fawn shade in a dyeing machine, and then spun on worsted frames. The imitation is not necessarily inferior in point of strength to the original, and large quantities of it are made.

The Making-up Trade.—A trade saying has it that the eye is more easily cheated with the needle than the yardstick. Freely interpreted, this means that there is a better profit in selling garments than selling cloth; yet it is not noticed that textile manufacturers are going into garment making on their own account. More and more they are having to look to the maker-up for custom. The retailing of cloth by the yard is dying out, and the draper who used to sell dress lengths now sells ready-made costumes. Even children's clothes are largely factory-made, instead of home-made, and the great staple of the ready-made suit trade is suits for boys. Business in ready-made suits for men makes no great headway, but there are large developments in the factory tailoring of clothes cut to individual measure. Everyone has seen how ready-made cloaks and coats have come into favour. It may have been observed, too, how the clothing manufacturers, especially of Leeds and the Midlands, have pushed the retailer out and become their own distributors. Changes of this kind have necessarily had their effects upon the conditions of cloth manufacturing. The makers-up want principally cheap goods chosen rather for smartness of appearance than enduring wear. They want to buy at certain fixed limits corresponding with the stereotyped prices for finished garments, and they are closely tied to particular dates and seasons. The quantities are large, and on the whole the terms of credit are short, but the profits in selling are not high. It might have been expected that the general substitution of wholesale for retail tailoring, dress-making, and so on, would have tended to produce larger orders to one pattern. In some directions this may have been the effect, but it is one of which little is heard. Everywhere manufacturers can be found lamenting that orders are smaller than they used to be, and entail very much more trouble and expense in execution. It is clear that there are centripetal as well as centrifugal forces to reckon with. Demands are more diffused than ever, and the efforts of manufacturers who wish to differentiate their goods from those that the wholesale makers-up are selling are assisting to disperse demand over an ever wider field.

The Dyeing Industry.—While there are manufacturers who elect to do their own dyeing, the work is more generally put out to the commission dyers. The capitals of the "combines" in the dyeing trade are some index of the magnitude of this department of work, and in addition there are census of production figures to show that commission bleachers, dyers, printers, etc., do substantially eighteen million pounds' worth of work in a year. Combination in the dyeing trade has spelt centralisation. The work has been segregated in the combined works, so that as far as possible one branch is kept to goods of one class. Accordingly, there are works in which nothing is dyed except blacks, year after year, and others which treat only with colours. The arrangement permits of great economies, and is in striking contrast with that of fifteen years ago, when dyers got what work they could, and dealt with it as they were able, at whatever expense in change of routine. The unsyndicated dyers occupy a similar position to-day, and are called on to execute widely differing classes of work. Conditions allow of no waste of time, and a rare aptitude is requisite in making an exact match to a shade that has not been attempted before. Dyers vary in their methods, some of them trusting most to formulae, and others mainly to the eye. Formulae in a mixed dye-house are not an unqualified blessing, and off-hand judgments are satisfactory when the eye is good, and profoundly to the contrary when the dyer is not in the accustomed trim. In these circumstances it is being found well to simplify colour-matching by

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restricting the choice of colours to three primaries, black and a few fine colours for use in screwing up the result to the desired shade. With a little practice it is easy to estimate the proportions of red, blue and yellow in a given shade, and easier to correct a fault when few and simple colours have been used. The restriction limits waste of colour and favours advantageous buying. As all who have touched them are aware, modern dye-stuffs are powerfully colorific, but there are individual dyers in the North of England whose affairs justify them in putting down contracts for as much as one hundred tons at once in one colour. Some of the combinations probably give out materially larger orders from their head offices, and mainly give them to the great German dye-ware firms, which in turn are members of combinations and parties to a "convention" for fixing minimum prices.

CORRESPONDENCE.

INDIAN RAILWAYS.

The subject of Indian railway extension is so important that I venture to ask you to find room in the next number of the *Journal* for this letter.

In the remarks I made on Mr. Neville Priestley's paper on Indian railways I stated that the only reason I was able to give for Government offering 5 per cent. on rebate terms to investors, was that Government had themselves grave doubts of the branch lines, open to construction by the public, paying 5 per cent. on the terms offered. Mr. Priestley, in reply, took exception to my attributing such "unworthy motives" to Government. The following will, I think, go a long way to prove that I had reason for what I wrote. The Karachi Chamber of Commerce have been urging upon Government the necessity of extending the metre-gauge railway from Hyderabad (Sind) to Karachi. In reply to the Chamber—with which reply the Government of India are "entirely in accord"—the Government of Bombay, in a letter dated April 19th, 1911, say: "I am to request that any further representation which your Chamber may desire to make regarding the extension of the metre-gauge, from Hyderabad to Karachi, may proceed on the basis of the line being constructed by Government as a State railway." With this letter is enclosed a copy of Paragraph 9 of the Railway Board's No. 59/14, dated June 25th, 1906, advising Government in this connection, which advice has been accepted, and is the reason for the decision to construct the extension by the State. The Railway Board say: "On question (2), viz., the agency which shall construct the connecting link . . . the Board are of opinion . . . that it should be made as a State railway for three reasons. The first is that it would be a *very profitable* one." The italics are mine. What is to be understood from this? Plainly it can only mean that, had it been probable that the extension would *not* have been "very profitable," private enterprise would have been allowed to construct it; being "very profitable" Government reserve it for themselves.

Writing in your *Journal* in 1895 on the rebate terms then offered, I remarked: "The truth is the Indian Government do not wish lines to be constructed by private enterprise. They have a very valuable monopoly and are by no means anxious that outsiders should interfere with their profits, or take the good things they hope in a few years to appropriate to themselves. Such feelings are, under the circumstances, natural, but it seems a pity that Government do not openly avow them, and thus save many would-be promoters the loss of time and money and the vexation of spirit that is the result of the existing system."

It appears that these remarks are as appropriate to-day as they were seventeen years ago.

J. FORREST BRUNTON.

NOTES ON BOOKS.

CHATS ON OLD JEWELLERY AND TRINKETS. By MacIver Percival. London: T. Fisher Unwin. 5s. net.

Of the admirable "Chats" handbooks on artistic furniture and personal ornament in course of issue by Mr. T. Fisher Unwin, this delightful volume, in octavo, of "Chats on Old Jewellery and Trinkets," by Mr. MacIver Percival, is of the widest interest and acceptability, not excluding Mr. Arthur Hayden's well-known "Chats on Old China." The guiding motive of the whole series, and its distinguishing merit, the honour of which belongs altogether to Mr. T. Fisher Unwin himself, is to serve the purposes of those who, mindful of the responsibilities involved in the spending of money, accumulate their artistic treasures not only for their own instruction, and pleasure in them, but as a sound investment, however inconsiderable, whether for their families or the nation. These "Chats" are, in short, all intended to be especially helpful to buyers and sellers; and naturally Mr. MacIver Percival's "Chats" recommends itself to a larger number of owners and producers, and middlemen and *virtuosi* than any others of its suite. But what makes this volume so valuable is that Mr. MacIver Percival is not only an experienced writer on its subject, and a recognised *connoisseur* in "Old Jewellery and Trinkets," but a practical jeweler himself, trained to the vocation at the "Central School of Arts and Crafts," and under the immediate direction of Mr. Alexander Fisher, Associate of the Royal Cambrian Academy, whose decorative work in sculpture, in gold and silver smithing, and in enamels and jewelry, has done honour to the artistic craftsmanship of the United Kingdom throughout the world. Mr. MacIver Percival's "Chats" is indeed the most comprehensive and

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the most thoroughgoing work, in a single volume, on "old" jewelry and trinketry known to me. In the briefest terms, after a general review of ancient and mediæval jewelry, he writes fully, through just 400 pages, on every denomination, and every style, of modern "old" jewelry and trinketry; all further defined and exemplified by over 200 illustrations reproduced on separate plates from photographs, and over 70 sketches, in outline, embodied in the text, a total of some 300 illustrations. In this way the volume is found to be a truly exhaustive encyclopædia of modern jewelry, from the Renaissance to the days of our picturesque grandmothers—dating them in their feathers, and falling ruffs [fallals], and fluttering furbelows, and sheen of famous trinketries, back to the days of Edward Pinchbeck and his son Christopher. With other Oriental jewelry, Mr. MacIver Percival also treats concisely of the jewelry of India, which is everywhere, from Cashmere to Ceylon, and from Karachi to Calcutta, the jewelry of Chaldæa and Babylonia, and Assyria, and of Egypt, and of ancient Greece and Rome, surviving down to the present century as a still living art and craft,—except where it has been degraded and depraved in its art, and shamed, and dishonoured, and deteriorated, in its craft, by the sinister influences of our English Schools of Art, and our general system of English education enforced throughout the country. For the fulness of its illustrations of trinketry the volume is a most "thankful boon" to the student of the history of the applied arts, the historical painter, the working jeweler, and collectors, to the humblest "snapper up of unconsidered trifles"; and last, but not least, to the providential pawnbroker, and his necessitous clients. It is a veritable "Vade-Mecum" for the isolated working jewelers, and the trading jewelers, and the pawnbrokers scattered about in the Cathedral cities, and county towns of the United Kingdom. For the most part they have never yet grasped the fact that the true value of jewelry is in its patterning and colouring, and not in the weight of its precious metals and stones; and therefore, notwithstanding that a jewel may be of the highest artistic or antiquarian interest, if there is nothing in it for the melting-pot or the carat-scales, they despise it as "but a gaud" [in Scotland *gowd*], and "a trinket"; at once to their own loss, and of their patron; for at this moment better bargains in jewelry, so far as artistry is the consideration, are to be made by amateurs of taste and learning, out of the derelict stores of the pawnbrokers, of even such "knowing places" as Glasgow, Liverpool, Manchester, Birmingham, and London, than at any previous period within my own experiences. "Gaud" and "jewel" are one and the same word with the Latin "gaudium," "joy," the first coming to us directly from it, and the second through the Low Latin "gaudiellum," and Italian *gioiello*, a jewel; all going back to the Sanskrit *gauras*, "yellow," "shining," "bright," "cheerful," etc.; and again, although "trinket" and "trickery" are the same word [going back to the Sanskrit *tarka*, "twisted," "a spindle," "interlaced wire-work"], both are also the same word as "torque," the Asiatic gorget, one of which taken from the neck of the Gaul he slew in single combat earned for T. Manlius and his descendants the honorific surname of Torquatus. It is the same word as *trousseau*, originally the bride's "truss" or twisted bundle, of wedding garments and trinketry. I have always found these illuminating etymologies of great use in selling off jewelry sent by the Government of India to International Exhibitions in this country and in France.

A greater evil, because of national consequence, is the general ignorance of our working jewelers of the history of their own craft, even of the materials, and the chemical and mechanical processes, and of the very tools used in its manipulations; and this incredible ignorance, aggravated by the miserable neglect of all such knowledge by the mass of the shopkeepers "doing business" in the craft, is the immediate cause of this country having lost, during the first half of the nineteenth century, the proud place it once occupied among the nations of the Western World for its gold and silver wares, and its jewelry, and its trinketry; and also its exquisite passementery, for it may be held to lie within the borders of trinketry. They know little, and oftener nothing, of what has been done before them, and by our very selves, in their most ancient art and trade, and triumphantly done,—"for [as both Shelley and Isaiah xl. 15, say] an eternal excellency, and a joy for ever." They are ignorant not only of the pre-eminent kimelionic exemplars of other ages and other countries, but of their own country and age. It is not for a moment meant that they should slavishly and mechanically copy the designs and imitate the styles of such masterpieces of their glorious craft; but they ought all to be more or less intimately familiar with them; and for the ever-quickening inspiration of their hearts, and minds, and souls in their individual handiwork:—"The flame of the fire will scorch his flesh; but in the midst of its glowing heat he will wrestle with his work; and the ring of his hammer on it will be heard all the day long; for his eyes are set on the goodly shape of the vessel in his hands, and his heart is set upon the patterning over it, to adorn his work perfectly." * It was in this spirit that the art-craftsman of ancient Greece, while resting at noonday from his labours, meditating on the wonderful world around him, and above him, came to call its

* As at Ephesus of old, everywhere in India, through all the sunny hours, is heard the ringing note of the coppersmith's hammer; and around the rural villages, from out the scattered groves, comes the answering note,—*tonk, tonk, tonk*,—of the little, verdigris green barbet, or "Coppersmith" of Anglo-Indians; and this antiphony between the men in the bazaars and the birds in the trees fills the whole brightness of the firmament above, as with praise "to the Holiest in the highest." So long as it lasts, one would fain listen to it; spellbound in profounder enchantment than of—

> "The olive grove of Academe,
> . . . . . . where the Attic bird
> Trills her sweet warbled note the summer long."

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Almighty Creator, "The Poet" [Ποιητής]. It is under the promptings of such divine inspirations that the handicraftsmen of India still daily, in the bazaars of a million cities and towns, and villages, heap up their jewelry of every denomination, in gold and silver, and precious stones [and not only for their women, but for their men, and children, and their pack-bullocks, and sacred cows, and horses, and elephants, and camels], as of the rich and rare spoil of Midian by Gideon, and of Seir by Jehoshaphat, and of the Persians at Platæa by the Greeks. When, on the "Cotton-crash" in Bombay, following the defeat of Lee, April 1st, 1865, at Five Creeks, I was asked to revalue a store of Indian Jewelry on which a loan had been advanced by one of the banks, the sight of it was as if I had suddenly come upon Hezekiah's own hoard of "exceeding much riches," in silver, and gold, and precious stones, and "all manner of jewelry," all of the antique models of a world that had come to a dead end in Europe 1,036 years before, almost to the very day! To the passing prostration of this mental, and moral, and religious stimulus between 1800 and 1851, is to be attributed the decay observable in most of the artistic industries of the United Kingdom within that period; and great as has since been the distinction achieved in every department of our textile and fictile manufactures, and in our domestic and ecclesiastical furnitures, and in metal work, including gold and silver work, all following on "the Gothic Revival" in Architecture, and notwithstanding what has been done in the present generation by individual goldsmiths, the revival has never yet manifested itself as of any national magnitude in our jewelry, sumptuary or democratic; and our "old" jewelry and trinketry remains, for the more fastidious of us, still "the only wear." The pre-eminent praise of Mr. MacIver Percival's book, emphasised by every page of it, is in its providing that inspiration; and by the simple means of handing down the historical, technical and artistic traditions of the beautiful objects he describes in so simple a form and so clear a manner as to render them understandable, and readily assimilable, by everyone, however imperfectly instructed, trained, and educated, and practically engaged, whether as working jewelers, or as business men, in the art and craft of "Old Jewellery and Trinkets." This is a matter of some moment; for the future of art is not with "the New Art" [l'Art nouveau], and "the Post-Impressionists" and "Futurists," but with the traditionists; and it is a future of unbounded hope and prosperity for all concerned with the decorative arts, and especially with jewelry and trinketry; and here is a book, a meet helpmate for them, wherein—"The very marrow of tradition's shewn," and so truthfully, so lucidly, and so invitingly, that "he may run that readeth."

The sum of the matter is this: in jewelry, as in every other creative work, tradition has to be observed and followed—or, at the end of a long life, the greatest jeweler will, at his best, but have arrived at the point from which he might have started, that is, the point of excellency attained by his professional predecessors; that the decorative details, and so far as possible the construction (where there is any construction other than what is provided by the details) are not to be arbitrarily dictated by the jewelry of foreign countries, ancient or modern, but by the living flora and fauna of his own country, and its national and local legends and heroical history, and antecedent artistic achievements; and that, this nowithstanding, any special power he may possess of giving artistic expression to these flower and animal fórms, and these spiritual inspirations, must still be exercised under the discipline of the traditions of his immemorial art and craft. Be assured no road to any heaven is easy:—

"Non est ad astra mollis a terris via."

None of the jeweler's individuality, if he has any, will be enfeebled by this severe discipline, it will be strengthened, and assert itself at its best; and while he will prize his design all the more for the flower that suggested it, he will thereafter love that flower all the more reverently for the consummate design he draughted from it. It was thus I witnessed the worship of the leaves of the "Indian Fig Tree" [*Ficus religiosa*], and of the silver "Fig-leaf" devised from them, for the wear, as their only vesture, and the earliest clothing of mankind according to the Biblical legend of Adam and Eve, worn by the wild Thakurs and Katharis of Western India; specimens of which were contributed by me to the International [London Annual] Exhibition of 1871, and described in my "Industrial Arts of India." The poorer women wore the natural leaf, the wealthier—as their reserved capital—the silvern leaf, fashioned to the exact heart shape of the natural leaf, but with its venation beaten out into the similitude of the *pipul* [compare our "Poplar," "populace," and "people"] itself, as "The Tree of Life"; a most scientific as well as most artistic convention; and although this silvern "Fig-leaf" is not the oldest actual jewel known to the world, in origin it is obviously the oldest ever fashioned by man.

A parting, well-earned word of praise is due to the printers and publishers for their part in the production of the book. In the colour and texture of the paper, the character of the types used, the legibility of the printing, and in the strength of the stitching and general "forwarding," it is everything that could be desired. But books on the artistic industries should be bound in the light blue of the eyes of Pallas Athene, and not, as in this case, in the dark, amethystine, or indigo blue of Hermes, the patron of mechanical industries, and artificers, rather than of arts-craftsmen and artists. But this is pardonable. The unpardonable solecism is that harsh daub of crude indigo along the top edges of the leaves of an otherwise accurately symbolical, and harmonious and firmly framed "format."

GEORGE BIRDWOOD.

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Journal of the Royal Society of Arts.

No. 3,115. VOL. LX.

FRIDAY, AUGUST 2, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

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S. Digby, C.I.E. (Secretary).

EXAMINATIONS COMMITTEE.

A meeting of the Examinations Committee was held on Friday afternoon, July 26th. Present:—Lord Sanderson, G.C.B., K.C.M.G. (Chairman of the Council), Sir William de W. Abney, K.C.B., D.C.L., D.Sc., F.R.S., Alan S. Cole, C.B., William Henry Davison, M.A., B. S. Gott, M.A., Dr. William Garnett, Sir John Cameron Lamb, C.B., C.M.G., Sir Philip Magnus, M.P., Hon. Richard Clere Parsons, M.A., Professor John Millar Thomson, LL.D., F.R.S., with G. K. Menzies, M.A. (Assistant Secretary of the Society).

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

This competition was instituted in 1878 by the Council of the Royal Society of Arts, as trustees of the sum of £400, presented to them by the Committee of the Owen Jones Memorial Fund, being the balance of subscriptions to that fund, upon condition of their spending the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, etc., regulated by the principles laid down by Owen Jones." The prizes are awarded annually on the Report of the Examiners in the National Competition of the Board of Education.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The following is a list of the successful candidates:—

Barlow, Albert E., School of Art, Salford, for a Design for Overmantel in Lustre Tiles.

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Billington, Frank, School of Art, Macclesfield, for a Design for a Woven Tapestry Hanging.

Faulkner, Howard B., School of Art, Dudley, for a Design for a Stencilled Hanging.

Grimshaw, Walter S., School of Art, Accrington, for Designs for Printed Cotton Dress Fabrics.

Timmins, Marion L., School of Art, Dudley, for a Design for a Stencilled Hanging.

Woodall, Bertram, School of Art, Dudley, for a Design for Chintz.

The Examiners who judged the works submitted for this competition report:—

"490 works were submitted for this competition, and the general level of merit shown last year has been maintained. As was the case last year, the best examples are the Woven, Printed, and Stencilled Fabrics. Some good Damask and fairly good Carpets, Embroidery, and Laces were also submitted."

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE MATERIALS AND METHODS OF DECORATIVE PAINTING.

By Noel Heaton, B.Sc., F.C.S.

Lecture I.—Delivered March 18th, 1912.

The Development of Decorative Painting.

My first duty in addressing you is to define what I mean by Decorative Painting, and to indicate the lines on which I propose to deal with the subject.

The term "painting" is a very wide one, including as it does on the one hand the work of the humble artisan who "beautifies" our doors and windows at so much an hour, and on the other extreme the work of the inspired artist who achieves undying fame by the execution of those pictures which grace the walls of our public and private buildings. Between these two extremes there lies a class of painting which is a work of art but not an end in itself, fulfilling, as it does, the definite function of completing and glorifying the building of which it forms an integral part; and that is what I understand by decorative painting.

Although I have placed it thus in an intermediate position, a great painting of this kind is, to my thinking, the highest possible achievement of the artist, because here he must work under restraint and limitations, at the same time expressing his own ideals and co-operating with the general scheme of the building his work is to complete. He must deny himself the freedom of the picture painter, and rise superior to, without ignoring, his limitations.

I think Hamerton has truly summed up the subtle difference between the picture and the decorative painting in his epigrammatic statement that a picture no more becomes a mural painting by being glued to a wall than a man becomes a statesman merely by reason of the fact that he has been elected a member of Parliament.*

Any discussion of the question of design is, however, beyond the scope of my appeal to you. My purpose is to emphasise the fact that not only is decorative painting the culmination of the work of the artist, it is also the culmination of the work of the craftsman; it demands equally the highest genius of the one and the highest skill and knowledge of the other. This being the case, I maintain that the study of his materials and methods is an essential and vital feature of the work of the decorative painter. I do not wish to suggest that the decorative artist, if I may use such a clumsy term, should be a scientist, but I do say, and say it most emphatically, that he should realise the necessity for this knowledge—this co-operation, we might almost call it, of art and science; for ignorance of the technical principles on which the execution of such work depends has been disastrous in the past and will be still more disastrous in the future. To put it on the most selfish grounds, one cannot expect patrons to encourage the execution of decorative paintings unless there is a reasonable expectation of the necessary outlay being justified by the future history of the work. Many lamentable cases of failure have come under my own observation—expensive works which have perished or seriously decayed in a few years, such decay nine times out of ten being due to defects in the process or materials employed—disasters which could have been avoided by a little technical knowledge, or by seeking efficient scientific advice at the time of execution.

The task I have set myself in these lectures, therefore, is to try to point out to such of you as may agree with me as to the importance of this aspect of the subject, the principles underlying the processes you employ in painting, the pitfalls by which your work is surrounded, and to give you such assistance as lies in my power to enable you to execute paintings which come within reasonable distance of realising that somewhat

* "The Graphic Arts," p. 164.

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optimistic saying that "a thing of beauty is a joy for ever." To this end I propose to devote this evening to passing in review the various methods of painting available; and in order to render this discussion of ways and means as interesting as possible I propose first of all to inquire, as a matter of history, how the various methods of painting now available came into existence.

We must go right back to Neolithic times to trace to its source the craft of decorative painting, for it is obviously the mother of all painting, and came into being as soon as primitive man developed the instinct to decorate the walls of his rude dwelling with signs and pictures. The natural beginning in all parts of the world was for the savage to gather such coloured substances as he could find around him, make them into a paste with some sticky liquid, and so spread them over any surface he desired to colour. Black, yellow, red and white are the colours one invariably finds in primitive paintings. Charcoal black obtained from the ashes of the fire, yellow from clay stained with iron, which we call ochre, red obtained by calcining the same yellow, whilst chalk or powdered limestone produced an excellent white; all these mineral pigments, or earth colours as we term them, are obtainable all over the world.

From such crude beginnings arose the decorative art of Egypt, which had developed to a highly advanced state as early as 4700 B.C., as is evident from the fragment of wall painting I now show you, representing a man holding a leopard by the tail, and executed in the reign of Sneferu. On examination of a section of this painting, it is evident that it was executed in the following manner: the rough surface of the mud wall was first of all levelled by a liberal coating of rough plaster, composed of Nile mud and chopped straw, which was followed by a thinner coat of finer texture, composed of powdered gypsum and very finely chopped straw. On this again the final smooth surface for painting was produced by a thin coat (about a sixteenth of an inch in thickness) of pure finely-ground gypsum. This plaster was allowed to dry, and then painted with such pigments as were available, the binding material being a solution of glue or size.

Although the naturalistic treatment of design shown in this example disappeared from Egyptian art for many centuries, being succeeded by a more formal and conventional treatment, this distemper process, as we might term it, remained at all times their method of painting, and we find it still in use in 1400 B.C., when the heretic king Akenhaten reintroduced for a time the naturalistic treatment, as evidenced by the paintings of the Palace at Tel-el-Amarna.

[Slides were here shown of examples of Egyptian mural paintings of different periods from the Third to the Eighteenth Dynasty.]

I have referred to these early paintings more particularly to emphasise the fact that you must not judge the durability of a painting by the evidence of ancient examples without reference to the situation in which they were placed. Although these examples have come down to us in a very fair state of preservation, they would not last for five minutes in this country unless placed under cover, for they will not resist the touch of a damp finger. Such a method of decorative painting is, in fact, only possible, except for the most temporary purposes, in a practically rainless country like Egypt, and in other contemporary countries where circumstances were not so favourable, we find that paintings executed in this manner have only survived in small fragments, and that they are largely replaced by sculptured stone, glazed brick, and so on.

But during the last ten years it has come to light that whilst those things were being done in the East there was arising that great Minoan Empire which dominated the Mediterranean Sea during the Bronze Age, and which had its centre in the island of Crete. Now, the climate of Crete is not like the climate of Egypt; it is more like that of our own island, and consequently we find developed there a more durable method of painting which the Egyptians apparently never thought of, because there was no reason why they should seek for anything better than distemper.

At least as early as the year 3000 B.C. the Minoan builders discovered that by merely mixing a pigment with water and spreading it over the freshly prepared surface of lime plaster they could colour that surface in a manner that was remarkably durable when exposed to weather. It would be beyond the scope of these lectures to describe in detail how the method of painting we call "fresco" was evolved from this beginning. It will suffice to indicate the method of working in the palmy days of the Minoan Empire, when civilisation was at its highest, and there flourished at the capital Knossos and elsewhere a great school of decorative painters, who from long tradition had developed a skill in this art which, to my thinking, has never been surpassed.

The wall was, if necessary, first rendered to a

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fair surface with rough plaster composed of lime mixed with an aggregate of pebbles and fragments of pottery, etc. On this was laid a first coat of fine plaster about half an inch thick, composed of pure lime, and on this again was laid the finishing coat, a quarter of an inch thick, to receive the painting, which was executed whilst the plaster was still wet, the pigments being merely mixed with water and laid on with a brush, and the work being executed with a rapidity and certainty born of established tradition and long practice.*

This was a necessity, because whatever was attempted must be finished without loss of time, for in fresco painting, as soon as the plaster is laid down the process of setting commences, which renders it insoluble, and, in doing so, binds the pigments firmly to the surface, a point which I shall discuss in detail in my next lecture.

Before I go any further I must remind you that the term fresco painting is frequently used at the present time in a generic sense, to imply *any* painting on a wall or building, however executed. I propose, however, to limit it strictly to a painting executed in the manner I have just roughly outlined, that being the original connotation of the word. This method of decorative painting has certain qualities which can scarcely be attained by any other method; qualities derived partly from the severe limitations it imposes upon the artist, and partly from the nature of the surface and the entire absence of anything in the way of a vehicle or medium, which is required in all other methods of painting in order to attach the pigments to the surface.

I have indicated that the Minoan artists developed this process to a high state of perfection; it was the art of the period, and every available space on their buildings—walls, ceilings, and even floors and stairtreads—were decorated in this manner.

The headquarters of this craft were at Knossos, the capital of the Empire, and there is reason for believing that not only did the artists execute work *in situ* in the great city itself, but that they made up the plaster in loose panels and exported finished paintings to other cities, to be built into the walls. I show you, for example, an illustration of a fresco discovered in the island of Melos, which was evidently exported in this way.

* For a more complete account of the technology of Minoan painting, see "Minoan Lime Plaster and Fresco Painting," *R.I.B.A. Journal*, September 30th, 1911.

With the overthrow of the Kingdom of King Minos, and the transfer of supremacy to the mainland of Greece, which occurred about the year 1400 B.C., we find the fresco painters flocking to Mycenæ and Tiryns, and continuing the practice of their craft, although in a less masterly fashion. The palace of Tiryns, originally excavated by Schliemann many years ago, has recently been re-excavated by the German Archæological School at Athens, and many fragments of fresco discovered, sufficient to enable a reconstruction of some of the original designs to be made, which work was only completed this year. I have the privilege of showing you photographs of these restored designs, which are of most remarkable interest.

[A number of autochrome reproductions of the frescoes referred to were here thrown on the screen.]

If you compare these designs, however, with those of Knossos, you will see that there are distinct signs of decadence, which is still more marked in the well-known figure of the bull, discovered at Tiryns by Schliemann. This marks the last stage of an art dying for lack of patronage, which appears to have come to a standstill altogether with the Dorian invasion.

The revival of the art in classical Greece was developed on different lines, sculpture becoming the established method of expression, and although decorative painting was pursued to a certain extent during this period our knowledge of it is very vague. We read, for instance, of the wonderful paintings executed by Polygnotus at Delphi; but, unfortunately, when Delphi was excavated by the British School at Athens recently no trace of these paintings was discovered to enable one to judge of the method of execution. But from the fact of their disappearance and other evidence which it would be outside our present purpose to discuss, it seems probable that during this period statuary was coloured and mural paintings executed in a manner similar to the Egyptian distemper painting, only with an improved medium prepared from yolk of egg, a process of painting known to us as "Tempera." In Egypt, during the Ptolemaic period, for instance, we find paintings executed in tempera by Greek artists, as an example of which I may refer to the remarkable series of coffin portraits discovered at Hawara by Professor Petrie, and exhibited recently at University College, when I had the opportunity of preparing the autochrome photographs of the best examples, which I shall now

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throw on the screen.* The earliest of these were painted in tempera on canvas, primed with a mixture of chalk and wax, which was laid over the canvas to form a thin coating like gesso. The later portraits on the coffins from the same cemetery, however, were executed in an entirely different manner, being painted on thin panels of cedar by the method we know as "encaustic," in which the medium consists of wax, which was melted and mixed with the pigments.

We thus find that by the dawn of the Christian Era, at least three methods of painting of a more or less permanent character were available, leaving out of account the soluble distemper of the early Egyptians; and it is probable that these three methods were employed side by side by the later Romans, who revived in a modified form the fresco process of the Minoans and used it extensively, in addition to tempera and encaustic. The Roman plaster was much thinner, the first coat being composed of lime and small pebbles, and the final coat, which was barely one-tenth of an inch in thickness, of lime and marble dust; a more extensive palette of pigments was employed in the painting, such substances as terreverte and red lead being used, in addition to the few pigments of the Minoans.

The method of painting in Roman times can be best studied at Pompeii, where we find unmistakable evidence that in addition to fresco, tempera and encaustic were also largely used —more particularly we find a modification of the latter, in which the painting was executed in distemper and then rendered durable by impregnation with molten wax— an easier method of execution than that of actually painting with the wax medium.

Fresco was very largely employed in this country for the decoration of houses in Roman times, as is evident from a study of the remains of many cities and detached villas which have been excavated. With the break-up of the Roman Empire there was another period of decline, followed in mediæval times by the rise of mosaic and then stained glass as typical methods of decoration. Decorative painting was, however, very widely practised throughout the Gothic period, as is evident from the many remains existing in our churches—such as these at Southleigh, Oxfordshire, which I now show you, these paintings being for the most part roughly executed in tempera.

* A "Portfolio of Hawara Portraits," containing facsimile reproductions of these portraits, will be published shortly by the Egypt Exploration Fund, University College, W.C.

With the dawn of the Renaissance of art and learning in Italy, decorative painting came into greater prominence, and, as we can gather from the many treatises written on the art, great attention was paid to the study of materials and the elaboration of the various processes. Encaustic painting does not appear to have been utilised to any extent, but tempera and fresco were widely practised. The latter was reintroduced about the close of the fourteenth century, and the problems surrounding it were deeply investigated, as we can tell from the well-known writings of Cennino-Cennini; many of the mediæval workers in fresco, such as Pinturicchio, frequently attempted greater elaboration than the method rendered feasible, and had recourse to after painting in tempera to complete their designs. The range of substances used as pigments was also greatly enlarged by continual experiments; and although amongst them many of doubtful durability were included, the painters, as a rule, were so familiar with their nature and properties as to be able to select their palette to ensure the best effect with the maximum durability.

Time does not permit me, however, to dwell at length upon the methods of the mediæval painters, which have been ably discussed on previous occasions; but, as their technical and manipulative skill increased we find that a new spirit began to spread over painting. There was a growing tendency to elaboration and subtlety of design, a striving for clearness of expression and realisation of natural detail which led to the seeking for a more facile medium, without the severe restrictions of tempera and fresco, a tendency which called forth the rebuke of Vasari, "Let all those who wish to paint upon walls paint in fresco like men, without retouching in secco, which, besides being a most vile practice, shortens the duration of the pictures."

Towards the end of the fifteenth century there came that utter revolution of the method of painting heralded by Alberti in his treatise, at the close of which he makes the remark: "It has been recently discovered that all colours can be mixed with linseed oil, and will last for ever, provided that the wall upon which they are put be very dry and completely free from damp."

The idea that the Van Eycks were the first to realise the peculiar property possessed by linseed oil of "drying," as it is termed, is, of course, long since exploded: we know perfectly well that drying oils had been in use for the humbler purposes of house decoration for generations

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before their time. But there is much to be said for the idea that they were the first to employ linseed oil, not alone, but in combination with resin, to ensure greater facility of execution. The secret of the method by which they produced their wonderful works perished with them, and it is impossible to identify it with certainty. It certainly was not known to their successors, who endeavoured, without success, to imitate them by using linseed oil—at first sparingly and then more freely—until they abandoned everything else and used linseed oil *alone* as their vehicle.

It is easy to understand that once this point was arrived at, the earlier methods of painting were soon entirely abandoned in favour of such a facile medium, which is the servant and not the master of the painter, allowing him to work out his composition as he goes on, and alter and repaint as much as he likes, instead of having to think it all out beforehand and execute his work with certainty and without pause.

This freedom from restrictions fostered the growing tendency towards the production of works of pictorial rather than decorative art, which, together with the demand for work of a portable character, gradually led to the abandonment of decoration in favour of pictorial art, and finally resulted in our own times in such a complete elimination of the earlier methods, that to the average man of to-day the word artist is almost synonymous with a painter of pictures in oils.

The distinction between a picture fixed on a wall and a wall painting has been largely lost sight of, both as regards design and method of execution, and huge pictures take the place of decorative paintings. But, apart from the fact that the limitations of technique and design imposed by these earlier methods of working are by no means an unmixed evil, as tending to simplicity and vigour, we find that an ordinary oil painting, for several reasons, is by no means satisfactory as a permanent work of decoration.

This fact has been generally recognised in recent years, and many experiments have been made in the modification of the process of painting, and also in the revival of ancient methods of working, experiments which have, however, frequently been a disastrous failure through ignorance of the scientific principles involved.

For, in executing work of this character to-day, and deciding upon the method of execution to adopt, we must frankly face the fact that conditions have changed, and that in many ways the problems that surround us are infinitely greater than they were in ancient or mediæval times.

We must face the fact that we have to contend with the impure atmosphere of our cities, contaminated with the products of combustion of coal, and the inevitable impurity that results from the massing together of enormous numbers, together with the concomitant evil of smoke and dirt, which necessitate paintings being so finished as to be readily cleaned. We have to face, moreover, the economic conditions dependent upon our modern civilisation; the fact that everything must be done in a hurry, and that in many cases the execution of a painting *in situ* is rendered impossible.

It is of no use ignoring these limitations; they are the penalties of modern life, and they must be grappled with and conquered. But there is no denying that they render all the more imperative a thorough understanding of his materials by the artist; in fact, the more experience one gathers the more one is forced to the conclusion that the production of a permanent work of decoration under modern conditions, is one of the most difficult problems of applied chemistry.

In order to resist decay efficiently the surface of the painting should be hard, elastic, and polished like a mirror—such a surface as the coach-painter produces on his panels by successive coats of varnish made of the hardest resins, each coat smoothed and brought to a dead surface before the next is applied. But such a smooth, glossy surface would be anathema in a decorative painting; what we seek for is a matt surface, so that the work can be seen in any light, and the brilliancy that can only be obtained by such a surface as that of plaster; such a surface in fact, as one knows from experience, is least calculated to resist decay, affording, as it does, foothold for every kind of dirt, and inviting the attacks of every kind of impurity.

In deciding upon the method of working, our problem is, therefore, to find a compromise between these two conflicting conditions; to obtain the maximum amount of durability with the necessary æsthetic quality.

Of course we must realise that no method is perfect; neither is there any method of painting which can be pronounced satisfactory under all conditions. At the best it is a fight with circumstances, but much may be done to defy the ravages of time by fully realising the defects and limitations of the various methods available, and by modifying them in order to secure the best results under different conditions.

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BRITISH FISHERIES.*

The Government in this country until very recently have paid very little regard to fishing. The first attempt of any kind of official organisation or control was by the Scotch, or it was the Scotch Fishery Board, and I should imagine myself that action points to the fact that the Scotch herring fishery is of much earlier date. It was fostered officially and watched over long before it was in England. The branded herring, of course, became the commodity of traffic, and when we commenced we sold to many nations large quantities of herrings. Then again one is reminded that the herring fishery is a very ancient institution, for the barrel of herrings, I dare say you will find in your reading, was looked upon as a measure of exchange. The value of a barrel of herrings was often quoted as a standard of value in commerce.

Size of the Industry.

With regard to the magnitude of the fisheries of Great Britain, in point of number of vessels we have gone down, but in point of value and in catch we have gone up. There appear to be, from the last Board of Trade returns, 24,459 fishing vessels of all classes in this country, and they landed, in the last year I have any record of, 1,133,711 tons of fish, so we have certainly provided food for the people. The value of that fish seems to be about 11½ millions sterling, and the value of the fishing fleet seems to be from 22 to 23 millions sterling. Now, going into detail as to where that value lies, in what branch of the industry, and what part of the country, you will find that we in this part occupy a very important position. The east coast, with which we are connected—Hull, Grimsby and the northern ports on the east coast—has provided nearly half of the whole fish landed, rather more than half a million tons, and the value of it is set out at £6,292,936. That is the east coast only. The south coast only contributed about 33,000 tons, valued at less than half a million of money, and the west coast contributed about 64,000 tons, being about one million in value. The whole of Scotland contributed rather less than half a million tons, and the value of it was two and a half millions. That is a summary of the value of our fishing trade. As to the vessels which you, with your mechanical and technical knowledge, have helped to foster, and have under your charge very largely—there appears to be £8,234,000 worth of property in what we call the deep-sea fisheries in Great Britain, and the value of the property in the herring fishery is £1,483,000.

Influence of Steam.

Now the steam herring boats are quite modern, as you know. Dealing with the fishing as a whole, of the 22 millions sterling it appears that steam vessels account for £11,687,000 and the small craft, trawlers and other description of fishing vessels, works out at another 11 millions. If you take your minds back only twenty-two years—when steam was first introduced generally, although it had been to a small extent in existence before that—in that period we have added to our value in that particular class of vessel half of the value of the fisheries of Great Britain. There appear to be 2,790 steam vessels in Great Britain, and of other craft over 20,000, making up 24,459, so that during the last twenty years we have been largely dependent on the skill of you gentlemen. In fact, by the technical knowledge of the engineer, combined with the practical knowledge of those who have embarked in the industry, we have produced a machine for catching fish such as never existed before. The steam trawler seems to be the envy of the world. Every part of the world where they now embark in fishing comes to Great Britain for the steam trawler, and notwithstanding the early development of other branches of the fishing industry we still hold the field; we claim our rights and say as trawling people we play an important part in the nation, and that we supply a very large moiety of the food of the people.

Figures from other Countries.

In order to compare this country with other nations, which were in the field before us, I have obtained some figures. There are Holland, Belgium, Denmark, Portugal, Russia, France, Canada, and the United States. I have not the details of the various ports, but so far as France is concerned they have, it is stated, 27,848 fishing vessels, and they employ 153,339 people, whilst the value of their fishery is £5,677,608. Now Holland, a nation of which I have spoken, have only 5,350 vessels, and 20,000 fishermen, and the value of their fisheries is a little over three-quarters of a million. Belgium appears to have only 460 fishing vessels, and the value of their fisheries is £250,000. Norway, another seafaring nation, appears to have 24,260 fishing boats, and 85,000 people employed, and the value of their fisheries is about 2½ millions. For Denmark I have not the number of the boats, nor the number of persons engaged, but their fisheries are supposed to be worth rather more than three-quarters of a million. The fisheries of Portugal, I was surprised to see, are valued at a little more than one million sterling. For Canada, our own colony, I have not the number of the boats, nor the number of men, but the value of their fisheries is said to be £5,240,000. Neither have I the details for the United States, but their value—and I take this to be the shore and not the lake fisheries—is just about half the value of the fisheries of Great Britain.

Is there any Depletion?

There is not the slightest doubt from everything I find recorded, and from my own observations, that the North Sea is one of the most wonderful fishing grounds in the world. It certainly provides

* Extracted from a lecture on "The Development of the British Fisheries during the Nineteenth Century," delivered by Mr. G. L. Alward, J.P., before the Grimsby Institute of Engineers and Shipbuilders.

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some of the most delicious fish, and a great variety, and it appears to be almost inexhaustible. Twenty odd years ago we thought we had got to the end of our tether. I remember a day in November of 1886. We opened an association to get an exchange of opinion amongst the fishing people of Grimsby as to whether something very serious had not happened, whether the trade had not come to an end, whether we had not exhausted the North Sea, and what was to be done for the future. Well, we have profited by experience, and we have had to let go the theories we held. But what has happened is this, that the Governments of this country, and of other European Powers, were roused to the fact that they ought to know more about the fishing industry, and so we had the International Sea Fisheries Exhibition held in 1882, which brought together the fishing instruments, the implements and the craft from all parts of the world, and we had an opportunity of seeing what was being done by the Americans, and by all the European Powers. I have already stated that we in Grimsby were to the front. We produced our ship, we competed against them all, we got our prize, and from that day onwards the Government of this country, and the Governments of the other countries of Europe, have been alive to the value of our great fisheries. But it was not until some time after that statistics were taken at all. We had our surmises as to whether there was more or less fish in some parts of the sea, and as to whether it was a permanent diminution, or only a temporary one. But now we have had scientific investigation, and I have previously tried to explain what is the outcome of that. We have now got a grip of the fisheries, and know much more than we did twenty-five years ago. As I have said, the North Sea is perhaps one of the most wonderful fishing grounds in the world. It covers 46,000 square miles. We still go fishing on the same old grounds, sometimes with good, sometimes with bad results. Then with these wonderful craft in which you are interested, we have gone further afield, and to-day we are fishing over an area of 170,000 square miles of fishing ground. So you see that, pessimistic as we were at one time, we are still going on. Whether we shall ever arrive at the climax I do not know.

"The Last Sole."

In going over these items I thought it very wonderful that in one's lifetime it should have been possible for one to have gone to sea in craft 35 ft. long and about as wide, fishing a few miles from the shore, thinking then we had got to the end of our tether, and then to see the result before us to-day. I remember an old fisherman at Scarborough, perhaps it was only a byword, of whom it was said he had been toiling hard for a long time catching soles, and he brought one pair ashore, and he held them up, and said: "The last pair of soles in the sea." We have not caught the last soles, we have not caught the last plaice. There is something very peculiar about fish, and the scientific investigation has revealed something we did not dream of. The Government now know something about fish, and there is no doubt we shall receive great benefit from that. But I was going to remind you that the area over which we are fishing now with craft belonging to Great Britain and other nations, extends from 30 degrees north to 70 degrees north, being a range of 2,460 miles north and south, with a longitude from 30 degrees west to 45 degrees east, a range of 2,250 miles. That is the area which I have already stated. That confirms what I have said about our fishing industry, that it is one of the most marvellous industries there is in the world, and I must say that Great Britain has to its credit some of the exploration of these distant waters. It is perfectly true that the French went to Iceland years before we did with their cod vessels, and it is true that the Dutch fished for the herring on the Dogger Bank before we did, but I have spoken of the Thames fishermen, and it is to the credit of Harwich, which had a considerable number of vessels in the seventeenth century, that they frequented the North Sea for line fishing, and it was at Harwich they adopted the Dutch system of building the vessels with wells in them in order to bring the fish alive to the market.

Ports that are Dead.

Harwich, as a fishing town, has died out comparatively. Barking, which was an industrious town, and had a large fishing fleet, has ceased to exist as a fishing town. Gravesend, for deep sea purposes, has ceased to exist as a fishing port, and one or two other ports have disappeared. I perhaps ought now to address myself a little more closely to what I mentioned before, that is, as to why some ports have died out, and why others have grown. The principal reasons in days gone by for fishermen locating themselves at some particular port were two. One was the nearness of the fishing ground, and the other was to be near the centres of population for the distribution of the fish caught. The old Brixham people, and also the fishermen of Plymouth, frequently caught the hake at certain seasons, a beautiful fish, but they had no possibility of placing it amongst the centres of population. They came up to Portsmouth with some of their fast little craft, one boat taking the cargoes of two or three, and reaching Portsmouth on the following day if possible. Large cargoes were also sent off for Billingsgate, but if the wind faltered they had to throw the cargo overboard and go back again. That was considered a crying shame, and the member for Brixham, to his credit, when salt was dear on account of the tax, secured a special permission for Brixham fishermen to salt their hake free of duty, and that gave an impetus to these people, and enabled them to get a living instead of having to destroy a large quantity of fish. They came up Channel and pitched their tent at Dover. That was the first step, the trawlers thinking they would do better if they were nearer to the centres of population. At Dover they found two wonderful fishing grounds,

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the Ridge and Varne, and round those banks, I have heard my father and others say, they got trawls full of beautiful turbots. The turbots came frequently but vanished again, sometimes not being found for a long time.

BIRTH OF HUMBER FISHERIES.

Then Ramsgate put in a plea, and the fishermen settled at Ramsgate. Some of the Grimsby people living to-day came from Ramsgate. I myself was born in Ramsgate. But there was no rest for the soles of their feet. They plied all the waters round the French and Dutch coast, working them for years. The more courageous of the fishermen came further north; they passed the River Humber, and located themselves at Scarborough. There they came into collision with the drifters. One man was thrown overboard, but his life was saved. This struggle developed, until the Government stepped in and said: "Hold your hand," and declared it was illegal to use a certain instrument which I shall show. In my time we had got as far as Scarborough. My first sea voyage was from the River Humber. We went further north, using Whitby, and the Tyne ports, and my father went, I believe in 1847, to Newcastle. I suppose they had never seen a trawl fish there in their lives before. And whilst we explored the waters along the shore we also went out further to sea.

THE FLEETING SYSTEM.

The Thames and the Devonshire fishermen, as they pushed further out to sea in the old days, were met with great difficulties as to getting their fish to market. With the variation of wind and weather they would not at times have a sufficient catch to bring to market, and eventually they had to resort to other means. One of the means adopted was the working together in companies at sea, sending their catch to port by one of the vessels, and in some instances sharing the spoil. Later, craft were specially built, which were faster sailers than the fishing boats, more like yachts, and these were called fish cutters, or carriers, and the owners at the famous port of Barking took the lead in this matter. The Hewitts and Morgans who were great fishing-vessel owners, built many of these special craft, and these same people introduced the idea of preserving the fish in ice. They pushed their operations far out into the North Sea, and on to the northern parts of the Dutch coast, and every day one of the cutters would take the fish from the fleet and convey it as quickly as possible to Billingsgate market. The Devonshire fishermen availed themselves of the opportunity of joining these fleets, and for years this was a prominent institution of fishing. The fish were packed first in baskets, sometimes in boxes. There was a charge for carrying, which in some cases was placed at one-fifth of the price made by the fish. This method called for continual improvement in the carriers, for increase in size, and when it reached its highest perfection a fleet of some twenty or thirty carriers plied through the waters all the year round. Of the energies put forward by the captains of these cutters many remarkable stories are told, such as a captain sticking to his helm from the time he left the fleet until he arrived at Billingsgate, often a thirty to forty hours' passage. This was carried on for some thirty years, the Devonshire fishermen who had come up coast adopting it, and in the early days fish was brought in these cutters either to London or to Grimsby and Hull. At length the distance became so great that steam power had to be adopted, and the Barking owners were the first to adopt it. About the year 1868 steam carriers were adopted, certainly of a somewhat rude character, but they answered the purpose well. Hull and Grimsby followed suit. Grimsby ceased the fleeting system some twenty years ago, but it was revived by one firm some twelve or fourteen years ago, though not for long. Now Grimsby has withdrawn entirely from fleeting, so that only Hull is left to follow that method, and Hull carries on one of the most permanently remunerative systems of deep sea fishing that is in existence.

ACCIDENTS ON INDIAN RAILWAYS.

Appendix XXII. of the Administration Report on Indian Railways for 1910 contains some figures of interest to manufacturers of railway rolling-stock, and to those responsible for its supervision and inspection before dispatch. Naturally this appendix takes account of collisions, derailments, floods, etc., but eight headings are given for accidents of rolling-stock due to failures of materials. Each class is further sub-divided into serious and other accidents. No deaths of passengers are attributable in either 1909 or 1910 to failures of materials, and only five cases of accidents to railway servants, of which three were fatal.

In 1910, the total number of accidents due to the bursting of boiler tubes was 257, as compared with 316 in 1909. There were, however, no fatalities due to these occurrences, only one man being injured in 1910. During these two years one boiler burst, but no one was either injured or killed on this occasion.

By far the most numerous accidents in both years were those due to the failures of engine springs and machinery, the figures given for these in the report being 892 in 1909, and 896 in 1910. No casualties of any sort arose from these accidents.

The next in numerical order are those accidents due to failure of couplings, the figures for these being given as 420 in 1909, and 435 in 1910, but again in no case was there any injury either to passengers or employees.

The failures of tyres, wheels, and axles, accounted for 76 accidents in 1909 and 52 in 1910, a decrease of about 68½ per cent. as compared with the preceding year.

On the other hand, accidents due to the failure of brake-gear rose from nine in 1909 to eleven in 1910, there being no casualties in 1909 and one in 1910. Accidents due to broken rails also rose from

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214 in 1909 to 272 in the following year, this being an increase of nearly 27 per cent. in one year.

Accidents due to failure of materials, although numerically the least, yet causing the greatest loss of life, were those owing to the falling in of tunnels, bridges, viaducts, and similar structures, of which accidents there were two in 1909 and four in 1910, those in the latter year involving the loss of three lives.

Taking these accidents as a whole, it appears that those due to failure of rolling-stock, permanent way, etc., in short, to items of plant which receive careful inspection at the manufacturers' works, 1,929 in 1909 and 1,931 in 1910, were only responsible for three deaths and two injuries in the two years.

Considering the enormous mileage of railway in the whole of India, and the capital represented by this, these statistics reflect great credit upon those responsible for the specifications to which the various items were made, and upon manufacturers and inspectors for careful oversight of the material used.

ARTS AND CRAFTS.

Examinations in Art.—The circular recently issued by the Board of Education on Examinations in Art seems to be causing rather more than the usual flutter generally raised by such official documents in educational circles. It will be remembered that the Board put forward a sort of outline scheme of examinations at the end of last year. The present circular is meant to be read in conjunction with that, and it is this combination of the two which is responsible for part at least of the present difficulty. A large part of the new syllabus treats of Fine Art, and has not to be taken into account here. The portion which deals with Industrial Design comes at the end of the document, and seems to have been drawn up with the idea of being as vague as possible. There is, of course, a good deal to be said in favour of not making a syllabus on rigidly hard and fast lines, but one which, with slight modifications and a few alternative provisions, covers thirty-one different crafts, leaves, of necessity, so much to be guessed at or inferred that it is not to be wondered at that the teachers are feeling a trifle bewildered. Again, the crafts in which students may be examined are set out in lists, and letters are placed after them to indicate whether they are to be regarded as involving, respectively, modelling (M), a knowledge of architecture (A), and the use of the figure (F), or any two or all of these subjects. That, again, is a wise arrangement, but the way in which the letters are allotted makes it appear as though the syllabus had been drawn up by architects and painters rather than by designers and craftsmen. Why, for instance, should every embroidress, illuminator, and jeweller be forced to offer the figure? It would surely be enough to allow workers in these crafts to do so if they so desired. It seems at first sight more reasonable to expect a knowledge of architecture from the wall-paper designer, the wood-carver, the tapestry designer, and the glass-painter; but when we turn to the earlier scheme, we find that architecture includes the "drawing of the classical orders to scale from memory, and of a plan, section, and elevation of a building." This does not look as though the kind of architecture contemplated were peculiarly well adapted to the needs of the class of students who are to be examined. It is, of course, far easier to criticise a syllabus than to construct one, and the framers of this particular scheme had a well-nigh herculean task before them. They have tried to provide tests which will ensure that in the future the possession of a Board of Education certificate in Industrial Design shall indicate a certain amount of all-round education in art as well as proficiency in one particular craft. If they have not succeeded in doing this in the best possible manner, that is largely due to the fact that for the most part they were not directly associated with the crafts and industries in question. It is to be hoped that, so far as Industrial Design is concerned, the present circular may be regarded as merely a preliminary and temporary scheme, to be supplemented at a later date by a series of more detailed syllabuses which, if put forward by the Standing Committee of Advice for Education in Art, will be drawn up with the advice and assistance of the experts who will presumably be appointed as examiners in the various subjects.

French Textiles at the Victoria and Albert Museum. — The collection of French textiles generously lent to the Victoria and Albert Museum by the *Mobilier National*, which is to be on view in the North Court of the Museum until October, is important from several points of view. In the first place, the seven large Gobelins, after Raphael's famous frescoes in the *Stanze* at the Vatican, have never before been lent to any museum outside France. They are fine examples of an early period of Gobelins manufacture, and, incidentally, an object-lesson in what can and what cannot be successfully attempted in tapestry of their kind. The splendid scene, crowded with figures in armour and rich array, of the Expulsion of Heliodorus from the Temple, though it lacks to some of us the qualities of the earlier Flemish work, is quite unusually satisfactory. The woman in the handsome damask dress in the Parnassus catches the attention at once, while the School of Athens, with its groups of half-naked or soberly-clad philosophers, in spite of being one of the earliest pieces shown, is poor and cold in effect. The Savonnerie carpets—of the period of Louis XIV., and very fine examples of their kind—are interesting as products of the earliest renowned manufactory of pile carpets in France. Though tapestry carpets were fairly common at this time, the making of pile carpets after the Oriental manner seems to have been rare in Europe, except in Spain, where, owing probably to the close connection with the

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East, they were produced at a much earlier date. The numerous velvets, brocades, and damasks which are shown in the various cases, form a very representative collection of the work of the Lyons weavers of the early nineteenth century—beautiful specimens of technique, often fine in colour, and with all the charm of really good silken fabrics. The embroideries as a whole are less interesting, but there is a small border with a renaissance pattern in gold thread, which is remarkable as being worked straight on to the velvet ground, Oriental fashion, instead of being applied. On the whole, one cannot help feeling that interesting and beautiful as these examples of French accomplishment and technical skill are, this is hardly an opportune moment for showing them. The English craftsmen of the modern school are bitten with the idea of simplicity at all costs, and the rather riotous design of the Savonnerie carpets, the set type of many of the patterns of the Empire silks, are the very last things to appeal to them. It seems, therefore, probable that many of those who might learn something from the masterly draughtsmanship and planning of some of these textiles, will see in them simply examples of a period with which (probably quite rightly) they are completely out of sympathy. The middleman, on the other hand, who is generally only too ready to receive with open arms anything to which he can attach the label of a French style, wants no encouragement to call for patterns which, whatever individual taste may think about their intrinsic merit, are undoubtedly better fitted to the genius of French than of English designers.

The School of Art Wood-carving.—The School of Art Wood-carving at South Kensington has been holding a rather informal little exhibition of the work done by the pupils taking the school's full course of instruction. There was no work executed for exhibition purposes, but a very interesting little collection of carving demonstrating what the first year, second year, and third year students have been doing during the year. It was schoolwork pure and simple, but it showed how well and thoroughly the pupils are trained, and quite accounted for the fact that the trade students find work at good wages when they leave the school, and that so many teachers of wood-carving all over the country have been trained there. A great deal of care seems to be taken to continue the education of the young students who are going to enter the trade on lines which have a bearing on their craft, whilst the drawings and designs on the walls, and the specimens of modelling scattered about the room, showed that the course is framed so as to give both them and the ordinary students something more than a knowledge of wood-carving technique. Casual students who join for a few lessons, of course, and the evening students, learn wood-carving only, but the regular pupils receive instruction also in the rudiments of those allied subjects which, indirectly at least, will help them so much in after-life. The school is remarkable not only for the work it does, but as an institution which teaches successfully both trade scholars and amateurs. Schools usually cater for the one type of students or the other, and both classes suffer a little from that fact.

The Allied Artists' Exhibition.—There is generally a small Arts and Crafts section at the Allied Artists' Exhibition at the Albert Hall, and this year was no exception to the rule. Besides a rather interesting stand of pots by Mr. Tunnicliffe, a satinwood grand piano, decorated in beaten copperwork by Mrs. Stannus, and a few exhibits in embossed leather, there were quite a number of cases of jewellery. Some of these were very much overcrowded, and looked as though the exhibitors had scraped together everything they could find—good, bad, or indifferent—instead of trying to make a good show of their best productions. There was, too, a certain amount of work which was rather more showy than beautiful, but some of the craftsmen sent exhibits worthy of better company. Miss Edith Linnell's chains and brooches showed a great taste and ingenuity in the manipulation of simple problems of design. They were the kind of things one would be glad to possess, and could live with without growing weary of them. Miss Florence M. Rimington sent some well-made and carefully-designed silverwork, clasps, etc., and Miss Ethel Virtue's little case included some work rather unlike what we usually see over here, and pleasantly reminiscent of some modern French jewellery.

CORRESPONDENCE.

A CERTAIN TUNIS POTTERY.

To find to-day, within thirty hours of Marseilles, the decoration of pottery of an archaic Greek type being actively carried on, would be astonishing did one not know the deep-rooted conservatism of the Oriental. It is for this reason that Tunis, built Phoenix-like out of the ruins of mighty Carthage, still retains many of the ideas, modes and customs of that earlier civilisation. Indeed, the besom of progress has but little disturbed, throughout the length of North Africa, the conditions of life of two thousand years ago. Along the shores of the Mediterranean one thing that strikes the most casual observer is the classic elegance of the humble pots and pans of domestic purpose in daily use from the Pillars of Hercules to its eastern extremity. It is obvious that all have a common origin, easily accountable, having in mind the facilities for maritime intercourse afforded by that middle sea. Pottery, that earliest of the arts, has from time immemorial been actively pursued in this region, and Tunis to this very day is famous for its household pottery. The ware is made not actually in the town of Tunis, but at Nabeul, not far away. The glazed pottery of Nabeul is very distinctive in character, the colouring being a rich green and yellow; a quaint

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fashion obtains there of glazing dishes and bowls half in the one colour, half in the other, with agreeable effect.

But it is of the unglazed pottery of Nabeul that I wish particularly to write. The cups, the bowls, the vases and water-bottles are of porous body, admitting of fairly rapid evaporation, and consequently keeping the liquid contents at a gratefully low temperature, a desirable consummation in a land where the climate is hot and water the universal beverage.

It is particularly the decoration and the mode of its execution that is so exceedingly interesting, pointing as it does to the survival of a most primitive method, certainly handed down from the days of Phœnician civilisation, when Carthage was the great mercantile metropolis of the known world.

The very archaic Greek character of its black decoration was what first attracted my attention; very similar in character to Mycenean in the British Museum, the decoration in both being evidently a colouring matter applied *after* the firing of the ware. My guide, after expressing surprise that such common pottery should interest me (you buy specimens for a penny or two), informed me that the black decoration could only be executed in the springtime, as the colouring matter had to be obtained from the juice of a certain tree. He, in due course, took me into the country and gathered the green pods of the wild caroub tree; the juice expressed from the pounded green pods was, he told me, the staining material used. I tried it and failed.

Later in the season I had many opportunities of witnessing the actual operation. The painter, seated on a door-step in the shade, very rapidly and cleverly executed the design that took his fancy. The horizontal bands were deftly made by turning the bottle or cup on his knee, whilst he held the brush, loaded with the vegetable juice, in the proper position; then the lattice work, or honeysuckle, or bird, or such other time-honoured design, was promptly added, and the object left to dry in the sun for a few minutes. The decorated portion was scarcely distinguishable from the clay body in colour previous to immersion for a short time in a bucket of water at the artist's side. When withdrawn, the decoration had turned a beautiful black.

After some persuasion, I induced the painter to sell me a bottle of the caroub juice. A timely-offered cigarette made the artist expansive, and he remarked: "You require something besides the bottle of juice to turn the paint black; there is more than water in the bucket I dip the pots in. I'll give you some of the stuff you must mix with it." Thereupon he went to his room and brought me a packet of crystals, which proved to be sulphate of iron (in Arabic, *zeudj*), and instructed me as to the quantity I should use I then knew why my own experiments had failed, and was at the same time profoundly struck with the unique process, one so primitive and yet so sufficing and so admirably adapted to its purpose, for it must be borne in mind that decoration which would interfere with the porosity of the ware would be undesirable; consequently any vitrified, fired decoration would, of necessity, be barred.

Apart from this, the close likeness, both in the manner and the matter of the decoration, to the early Græco-Egyptian pottery was strongly impressed upon me, particularly as in the Bardo Museum at Tunis and the Museum of the White Fathers at Carthage, specimens four thousand years old, dug up on the latter site, were in evidence for comparison.

In conclusion, I must say I was surprised at being told by Tunisians themselves, that until I had investigated the process of the decoration of this particular ware, no one had evinced any interest therein. Knowing as we do how slowly the East changes, and how unique, as far as I am aware, is the process of this decoration, is not this obviously a craft survival handed down through the centuries and identically the same method as that pursued by the Phœnician predecessors of the present-day Tunisian?

It is pleasant to think that Dido was probably refreshed with a draught of cold water, poured out of a similar bottle into a similar cup to those which are in use to-day on the site of the city of her former greatness.

HERMAN HART.

PAPAYA OR PAWPAW.

I notice in the *Journal* of March 1st that Sir George Birdwood has written a short paragraph on the Papaya or Pawpaw. It is very largely grown in most gardens in this province, and many natives are now cultivating it. It is generally known here also as Pawpaw, though I have endeavoured to induce people to call it Papaya, but without success.

Where fruit, except bananas, and vegetables are scarce, we look upon the fruit as delicious, and it is a great digestive.

It may not be generally known, and perhaps Sir George Birdwood may not be aware of the fact, that by wrapping up a joint of meat in the leaves of the Papaya for two or three hours, the toughest meat becomes very tender.

The African kuku (chicken), even a champion sprinter of many years' standing, can be made in this way as tender as a spring chicken.

R. C. R. OWEN,
Governor, Mongalla Province, Sudan.

THE ROYAL SOCIETY OF ARTS AND FORESTRY.

A reader of the *Journal*, who has been for twenty-five years a near neighbour of Windsor Park and Forest, writes:—

"In the very interesting ninth section of the history of the Royal Society of Arts published in your *Journal* of July 12th, Sir Henry Trueman Wood mentions that complaints of the lack of

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timber were rife as far back as the Restoration. But Mr. Menzies, in his 'History of Windsor Park and Forest,' mentions that, still further back, Queen Elizabeth was much perturbed at the prospect of the destruction of the forests where the oaks for the British Navy were grown.

"When the invasion of the Armada was threatening, she gave special orders that the coasts of the Bristol Channel and the English Channel should be specially protected, because the Spaniards would be sure to destroy the timber in the Forest of Dean, and she also caused then and there to be planted a considerable area of oak plantation in Windsor Great Park. Mr. Menzies is able to identify almost the exact site of this plantation, and its hoary survivals."

OBITUARY.

Earl Ferrers.—Earl Ferrers died at his residence, Staunton Harold, Ashby-de-la-Zouch, on July 26th. He was born in 1847, and succeeded his father in the peerage at the age of twelve. He was educated at Trinity College, Cambridge. Lord Ferrers was a Knight of Justice of the Order of St. John of Jerusalem, Provincial Grand Master of Freemasons of Leicester and Rutland, J.P. and D.L. for Leicestershire and Staffordshire, and J.P. for Derbyshire. He became a member of the Royal Society of Arts in 1880.

Frederic Julius Macaulay. — Mr. F. J. Macaulay died on July 18th at his residence on Clapham Common at the age of eighty-two. He was connected with the London and South-Western Railway for over sixty-one years. Entering the secretary's department at Waterloo, he was appointed assistant secretary in 1865, and secretary in 1880, finally becoming a director in 1898. In addition to his work on the staff of the London and South-Western Railway, Mr. Macaulay was connected with various other railway enterprises. He was one of the promoters of the Waterloo and City Electric Railway, and of the Axminster and Lyme Regis Light Railway. He had been a representative director of his company at the boards of the West London Extension, the North Cornwall, and the Somerset and Dorset Railway Companies, and was a representative member of the Railway Companies' Association. He also acted for a short time as Chairman of the Demerara Railway Company. His interest in the South-Western Railway staff was indicated by close identification with the benefit funds and friendly societies which its members established. He was also on the governing body of the Railway Benevolent Institution. Mr. Macaulay was an Associate of the Institution of Civil Engineers, a Fellow of the Royal Geographical Society, the Zoological Society of London, and the Institute of Directors. He was a Past Master in English Freemasonry, and a freeman of the City of London. He became a member of the Royal Society of Arts in 1896, and as long ago as 1856 a letter from him was published in the *Journal*, in which he urged the establishment of a system of examination of classes by the Society.

NOTES ON BOOKS.

Lectures on British Commerce. By the Right Hon. Frederick Huth Jackson, G. Armitage-Smith, M.A., D.Litt., Robert Bruce, C.B., and others. London: Sir Isaac Pitman & Sons, Ltd. 7*s*. 6*d*. net.

This volume contains ten of the lectures which were delivered by well-known authorities at the meeting of the International Society for the Promotion of Commercial Education held in London last year. In the first, Mr. Huth Jackson gives an admirably lucid account of the Bank of England. An abstract of the lecture was printed in the *Journal* last year. Dr. Armitage-Smith follows with a succinct description of the British system of taxation, and an excellent epitome of the postal organisation, with special reference to the London Postal Service, is given by Mr. Robert Bruce, C.B., Controller of the London Postal Service. The remaining lectures are: "London as a Port," and "The Machinery of Marine Insurance," by Douglas Owen, Barrister-at-Law, late Secretary of the Alliance, Marine and General Assurance Co.; "British Shipping," by W. E. Barling, Editor of the *Shipping Gazette;* two lectures on fire, life, industrial and other kinds of assurance, by J. J. Bisgood, B.A., Secretary in London of the Edinburgh Life Assurance Company; "The Economic Position of the Coal Industry of the United Kingdom," by Allan Greenwell, F.G.S., A.M.Inst.C.E., Editor of the *Colliery Guardian;* and "The Woollen Industry," by James Graham, Secretary for Education, City of Leeds.

These, of course, form but a very small portion of the lectures which were delivered at the meeting, but they have been carefully selected as excellent examples of the style and character of the others. They are designed in the main for a foreign audience who, although possessed of a general economic and commercial education, have no detailed knowledge of English conditions. The organisers of the London meeting of the International Society for the Promotion of Commercial Education were certainly fortunate in the lecturers whose services they secured; and it is gratifying to learn from the introduction by the Hon. W. Pember Reeves, that their efforts were rewarded by a large and eager attendance of foreign students. It was an excellent idea to publish a selection of the lectures in permanent book form.

Photographic Copyright. By George E. Brown, F.I.C., and Alexander Mackie. London: H. Greenwood & Co. 1*s*. net.

The Copyright Act, 1911, came into force on July 1st, 1912, and introduces important reforms in the

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law of the subject. The appearance of this volume is, therefore, very opportune. It is issued from the office of *The British Journal of Photography*, and is a working guide among the intricacies of copyright law for any photographer having occasion to dispose of the rights of reproduction in his photographs. The rights of the photographer in reference to the photographs taken of sitters in various circumstances and the rights, on the other hand, of sitters in their photographs are explicitly dealt with, so that the volume forms a reliable aid to portrait photographers in deciding business disputes. Conditions of obtaining copyright in foreign countries, and particularly in America, are fully dealt with. The pages are freely cross-referenced, and a full index is provided, while the Act itself, or rather such part of it as refers to photographic copyright, is printed as an appendix. The subject is from its nature somewhat difficult and intricate, but the authors have succeeded in dealing with it in a simple and comprehensible manner.

GENERAL NOTES.

The Institute of Metals.—Next month the Annual Autumn Meeting of the Institute of Metals will be held in London for the first time since the Institute's formation in 1908. In that year the Institute met in Birmingham; in subsequent years meetings were held in Manchester, Glasgow, and Newcastle-upon-Tyne. Arrangements for the meeting to be held on September 25th and 26th are in the hands of an executive committee composed of the London Members of Council of the Institute. The meeting, for which ten papers have been presented, will open at 10.30 a.m. on Wednesday, September 25th, at the Institution of Electrical Engineers, Victoria Embankment, W.C. During the morning a series of papers will be read and discussed, Professor W. Gowland, F.R.S., President, being in the chair. In the afternoon members will proceed either to the works of Messrs. Fraser & Chalmers, Ltd., Erith, or to the National Physical Laboratory, both of which will be open to their inspection. In the evening there will be a reception, by the President, of the members and their ladies, which will take place at the Royal United Service Institution, Whitehall, S.W. On Thursday, September 26th, papers will be read and discussed at the morning session of the Institute at the Institution of Electrical Engineers, and in the afternoon alternative excursions will take place, one being to Woolwich Arsenal by special steamer from the Embankment, and the other being a visit to the Brooklands motor racecourse and aviation ground, special motors being provided for the conveyance of the party. Anyone desirous of taking part in the meeting should communicate with the Secretary, Mr. G. Shaw Scott, M.Sc., Caxton House, Westminster, S.W.

Importation of Italian Rice to the Argentina.—The decline in the quantity of rice imported to the Argentine Republic from Italy is causing some anxiety among the rice-growers in the Provinces of Novara and Vercelli. The imports of this cereal, which amounted to 67,167 tons in 1907, fell gradually to 44,700 tons in 1910, a decrease of 33·45 per cent., or one-third in three years. This decline may, to some extent, be attributed to the competition from Egyptian and Asiatic-grown rice, a great proportion of which is imported with the husks, as *riso mezzo lavorato;* this pays a lower rate of duty, viz., 270 francs per quintal (about 1*s.* 1¾*d.* per cwt.), as compared with the *riso lavorato*, or perfectly clean Italian article, which pays 10·80 francs per quintal (4*s.* 5*d.* per cwt.). 92 per cent. of the rice imported from Italy belongs to this class. A large quantity of rice is now grown in the Province of Buenos Ayres, and naturally pays no duty. It is probable that this tariff, which falls heavily on Italian-grown rice, may be modified in view of a possible reduction of the duty now levied in Italy on meat imported from Argentina.

Departmental Committee on Flax Spinning and Weaving.—The Home Secretary has appointed Commander Sir Hamilton Freer-Smith, C.S.I., R.N., formerly Superintending Inspector for Dangerous Trades (Chairman), Professor J. E. Petavel, F.R.S. (Professor of Engineering in the University of Manchester), Professor J. Lorrain Smith, F.R.S. (Professor of Pathology in the University of Manchester), Mr. G. Herbert Ewart, of Messrs. William Ewart & Son, Limited, Bedford Street, Belfast, and Mr. Henry Cummins (Chairman of the Weavers and Winders Trade Union, Lurgan), to be a committee to inquire and report what amendment (if any) of the regulations for the spinning and weaving of flax or tow and the processes incidental thereto, is expedient in view of the Report of the Departmental Committee on Humidity and Ventilation in Cotton Weaving Sheds, or on other grounds. Mr. D. R. Wilson, H.M. Inspector of Factories, has been appointed Secretary to the Committee.

Production of Precious Stones in Siam.—Some years ago it was estimated that five-eighths of the world's supply of sapphires came from the alluvial workings of south-eastern Siam, where these gems have been sought after by Shans and Burmese for many generations. Statistics as to the yearly amount of sapphires produced are not available, as they are free of both inland taxes and export duties. Rubies are found in the districts of Chantabun and Krat in eastern Siam, but those of good colour are small, while the larger sized ones are of poor colour, but it is said that the better quality of rubies are sent overland to Burma, and are there sold as Burmese rubies. The gem industry is in the hands of Burmese and Shans, and the alluvial deposits are washed by hand in the streams. The trade in gems is chiefly carried on by natives of India, Burma, and Ceylon.

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Journal of the Royal Society of Arts.

No. 3,116. VOL. LX.

FRIDAY, AUGUST 9, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

COLONIAL SECTION.

LIST OF COMMITTEE.

Lord Sanderson, G.C.B., K.C.M.G. (Chairman of the Council).
Lord Blyth (Chairman of the Committee).
Earl of Aberdeen, G.C.M.G.
Sir John Anderson, G.C.M.G., M.A., LL.D.
Thomas Jewell Bennett, C.I.E.
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Sir Frederick Young, K.C.M.G.
S. Digby, C.I.E. (Secretary).

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE MATERIALS AND METHODS OF DECORATIVE PAINTING.

By Noel Heaton, B.Sc., F.C.S.

Lecture II.—Delivered March 25th, 1912.

Fresco and its Modifications.

In our brief historical survey last week we arrived at the result that the works of the past were produced by various methods of painting, which we may tabulate thus:—

A. Pigments incorporated with the ground, no medium being employed . . . Fresco.

B. Pigments fixed to the ground by means of an organic medium:—

Size or glue soluble in water . .	Distemper.
Emulsion miscible with water, but insoluble on drying	Tempera.
Oil "drying" by chemical action .	Oil painting.
Melted wax	Encaustic.

We have now to consider these processes individually and discuss the problems involved in their use, which in each case divides itself under three heads:—(1) the ground to paint on; (2) the pigments; (3) the medium or vehicle. My purpose this evening is to consider in detail the first of these two main branches—that which we know as fresco.

The essential characteristic of fresco painting is that the binding medium is inorganic, and, in fact, part of the ground itself, so that the third factor is really eliminated, no medium whatever being actually mixed with the pigments on application, other than pure water. Everything depends, in fact, on the nature of the ground in fresco painting, and in order to have a clear idea of the possibilities and limitations of the process it is essential to know something of the principles involved in this peculiar action of the fixing of the pigments by the hardening of the plaster. The ground of

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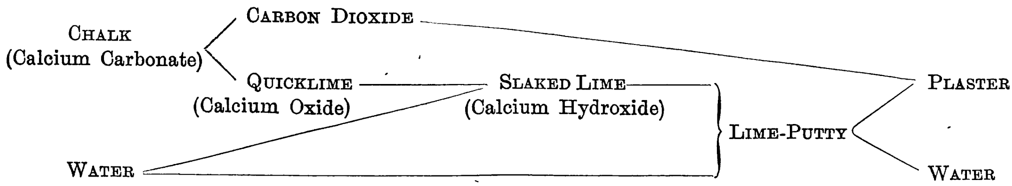
fresco painting is essentially some form or other of lime plaster, the production of which depends upon the cycle of changes indicated in the diagram:—



The familiar fact that chalk, on being heated, is converted into quicklime is explained by its chemical composition, which is that of lime, or calcium oxide, in combination with a substance which results from the burning of coal, known as carbon dioxide. But the combination between these two substances is not very strong. When, for instance, chalk is heated in a lime-kiln the heat destroys the combination—the carbon dioxide, being a gas, escapes up the chimney, leaving the lime behind. We call this "quick-lime," because it is chemically active, or eager to combine with anything else—more particularly, as you are aware, if you add a little water to it, the two combine together chemically to form a new substance which the chemist calls calcium hydroxide, and the builder's foreman "slaked lime."

The power of quicklime for combining with water is, however, strictly limited; when half a hundredweight of quicklime has combined with eighteen pounds of water its powers are at an end, the whole of it being converted into slaked lime. You must understand that this slaked lime would be perfectly dry; both the water and the quicklime have ceased to exist.

If a greater proportion of water is used than is required to effect this chemical reaction, a small proportion of the slaked lime first formed will dissolve in the excess of water, but only a small proportion, and the remainder will mix with this solution mechanically to form a stiff paste, which is familiarly known as "lime-putty." This lime-putty is the material used in making lime-plaster, and the cause of its operating in this way is due to a reversal of the process I have just described.

When the lime-putty is spread out on a wall, or exposed to the air in any way, first of all the water commences to evaporate. This naturally results in some of the slaked lime being deposited from solution, which locks together, as it were, the solid particles already present, causing the whole mass to stiffen, or "set" into a firm mass. Now the carbon dioxide has been hovering around in the air all this time, and the moment you leave the plaster alone, and there seems a prospect of peace and quietness, it gradually combines with the lime again, with the result that finally the whole mass of plaster is re-converted into its original form, and becomes once more a hard mass of insoluble chalk.

That is the explanation of the setting of lime-plaster, and if I have made it clear you will readily understand how fresco painting becomes possible, for after the first setting of the plaster has taken place you have a practically solid mass of soluble slaked lime saturated with a solution of the same substance. If you now make any pigment into a paste with pure water and apply this to the surface every particle of the pigment will be saturated with the solution of slaked lime in the same way, and as this is on the surface it first hardens by evaporation of the water, and is almost at the same time attacked by the carbon dioxide and converted into chalk, the result being that every particle of pigment is actually surrounded by and incorporated with the substance of the plaster, the whole forming one rigid mass.

The extent to which the pigments placed on the surface of the plaster in fresco painting are actually incorporated with the substance of the plaster itself, can be clearly seen from the photomicograph I now show you of a section of the surface of a fresco painting.

I have assumed for the moment, in order to make my description clear, that the plaster consists entirely of lime-putty, without any admixture, as it is on the reactions that take place in this material that the setting depends. It is a generally accepted fact, however, amongst practical plasterers that a plaster composed entirely of slaked lime is not satisfactory, and that some inert material must be mixed with the lime in order to produce a satisfactory plaster. It is true that the plaster used by the prehistoric fresco painters of Knossos is composed entirely of carbonate of lime; although, at first sight, this would seem to indicate that it was originally composed entirely of slaked lime, that is not necessarily the case. It is possible that the

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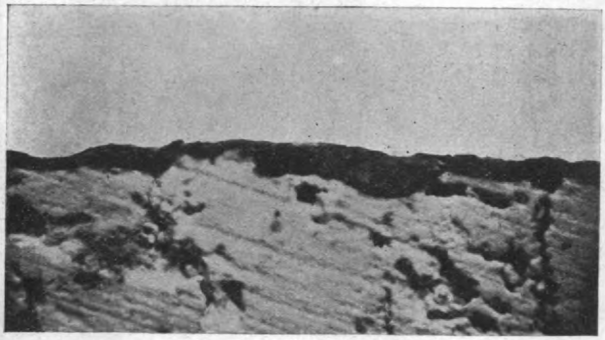
inert material consisted of the same limestone from which the lime was prepared merely reduced to powder, without being burnt.* The Roman craftsmen mixed their lime-putty with a considerable proportion of coarsely-powdered marble or similar material, varying in nature according to the resources of the district in which the work was executed.

This practice was continued by the mediæval fresco painters, as we learn from practical examination and from the various treatises on the craft, notably that of Cennino Cennini, whose methods have formed the model on which such examples of fresco as have been produced in modern times have been based.

Briefly stated, the method adopted, as described by Mrs. Sargant Florence,† is as follows. The wall is first "rendered" with a coarse rubble plaster composed of lime and pounded brick or pottery; the intermediate plaster (or Arricciato, as it was called by the Italian workers), composed of lime-putty and sand, is laid on this as soon as the initial setting has taken place, three or four coats of this being frequently applied. The wall is thus brought to a dead smooth surface to receive the final thin coating of fine plaster or intonaco on which the painting is executed. This last coat is composed of lime-putty and finely-powdered white marble, and is, as a rule, little more than an eighth of an inch in thickness; with such a thin coating the process of initial setting is comparatively rapid, and in order to secure thorough incorporation of the pigments with the ground, it is necessary that they shall be applied within a few hours of laying the intonaco. This necessitates laying the intonaco in sections, only as much being put on as can be painted in one day, this amount varying of course with the intricacy of the portion to be painted; in the finished work the line of junction between each successive day's work can often be clearly seen on close examination, as in the mediæval example I now show you.

Very little has been done in modern times towards investigating the possibilities of improvement in the plaster used for fresco work, and the use of such materials as asbestine, or finely-powdered asbestos in replacement of marble dust. There is, in fact, a wide field of research open in the direction of modifying the composition of the plaster with a view to making it more easy to work with, and more especially with a view to making it more resistent to decay. Modern workers in fresco, as a rule, follow doggedly the directions given by Cennino Cennini, and endeavour to reproduce the tradition of mediæval Italy, without any attempt to enlist the resources of modern science on their behalf.

I shall refer to what has been done in this direction later, but before doing so I must say a few words about that other great factor in the



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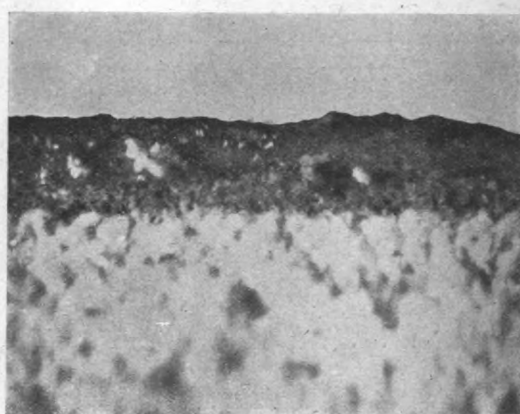

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FIG. 1.

a. Section of surface of fresco painting (× 50), showing how the pigment penetrates the surface.

b. Comparative section of painting in oil on plaster (× 100), showing the sharp line of junction between the paint and the ground.

* Since these lectures were delivered I have completed an investigation of the frescoes discovered at Tiryns, and have succeeded in obtaining definite proof that this was the practice followed in their execution; the bulk of the plaster was prepared by mixing powdered limestone and lime-putty, pure lime being used, however, to produce the final smooth surface for painting on. It is quite conceivable that the later practice of adding marble dust to the lime originated in the fact of this marble having been used as the source of the lime.

† Papers of the Society of Painters in Tempera.

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painting which I have so far ignored—namely, the pigments.

It is obviously impossible for me to attempt any detailed description of the nature and properties of pigments in the time at my disposal, nor is it necessary for me to do so, as many excellent works have appeared on the subject. I will merely attempt to remind you of the main facts concerning them by means of the accompanying summary:—

SUBSTANCES USED AS PIGMENTS.

Class I.—Metallic Oxides and Salts.

Division 1.—Mineral Whites.

Silicon	Silica Asbestine (*powdered asbestos*)
Barium	Barytes (*Blanc fixe: Process White*)
Calcium	Chalk (*Whiting: Paris White*) Terra Alba (*Gypsum*)
Aluminium	Alumina China Clay (*Kaolin*)
Zinc	Zinc Oxide (*Chinese White*)

Intermediate—Earth Colours.

Mineral Whites stained by iron and manganese	Ochre Sienna Umber Terreverte Vandyke (artificial) Naples Yellow (artificial)

Division 2.—Coloured Compounds.

Iron	Iron Oxide (*Indian Red, Venetian Red, etc.*)
Manganese	Manganese Brown
Copper	Malachite Egyptian Blue
Cobalt	Aureolin Cobalt Blue Cobalt Green Cerulean Blue Smalt
Chromium	Chromium Oxide Viridian Chrome Yellows
Lead	Red Lead White Lead (*Flake White*) Sublimed White Lead Naples Yellow (original)

Class II.—Sulphur Compounds.

Lapis Lazuli
Ultramarine (*New Blue: French Blue*)
Cadmium
Vermilion
King's Yellow
Lithopone

Class III.—Semi-Organic Compounds.

Prussian Blue (*Chinese Blue: Antwerp Blue*)
Emerald Green
Verdigris

Class IV.—Organic Substances.

Lamp Black (*Vegetable Black*)
Ivory Black
Graphite
Asphaltum (*Bitumen: Mummy*)
Bistre
Vandyke Brown (natural)
Sepia
Carmine
Gamboge
Indigo
Indian Yellow (*Puree*)

Class V.—Lakes.

Natural	Crimson Lake: Madder Lakes Italian Pink: Sap Green, etc.
Artificial	Lakes from Aniline and Alizarine dyes, etc.

We are more particularly interested this evening in the selection of pigments for fresco painting. The great point to bear in mind in considering the advisability of using any pigment for this process is the energetic chemical nature of the caustic lime to which the pigments have to be applied. Anything of an organic nature is immediately destroyed, which rules out at once the large number of pigments comprised in Classes III., IV., and V., with the exception of the blacks produced from carbon itself (lampblack, vegetable black, ivory black, etc.). Also you have to bear in mind the fact that the pigments are exposed under the most drastic conditions of exposure possible—laid on a freely absorbent surface and exposed to light and air without any protection except that afforded by the film of porous lime around them. Only pigments of the highest order of permanency are, therefore, possible, and even those in Class I. that are liable to change in impure air, such as white lead, must be avoided.

In the following list I have indicated which of the substances referred to in the previous classification are available in fresco painting and which must be avoided. The intermediate column, headed "may be used," contains certain pigments which have been extensively utilised in fresco, as they are perfectly stable against the effect of caustic lime, but which, nevertheless, I consider had better be avoided in work executed under modern conditions, as they are liable to be affected by an urban atmosphere containing sulphuric acid and other sulphur compounds, or to affect other pigments injuriously. Such a substance as ultramarine, for example, is perfectly fast to light and alkali, and can even withstand heat without injury, and on account of its beauty was rightly cherished almost above all other pigments in mediæval

times; although one of the most durable of pigments under normal conditions, however, it has one weakness in common with the plaster itself—that of being destroyed by the weakest acid, and therefore, as we shall see in a moment, it is quite unreliable in our modern contaminated atmosphere. This affords an excellent example of the danger of blindly following mediæval traditions in modern work.

of the thorough slaking of the lime before use, but without, I think, always appreciating the principle involved, because they insist also on the tradition derived from mediæval times that the longer the lime-putty is kept the better it will be for the purpose. It is true that thorough slaking—that is to say, the conversion of every single particle of calcium-oxide into calcium-hydrate by combination with water, is of the

	Freely Used	May be Used	Inadmissible
Class I.	Zinc Oxide Ochre, Sienna, Umber — Raw and Burnt Artificial Earths Indian Red Venetian Red Light Red Cobalt Green Cobalt Blues Smalt Egyptian Blue Chromium Oxides	Terreverte Malachite Red Lead Sublimed White Lead Naples Yellow	Aureolin Chromes White Lead
Class II.	None	Vermilion Ultramarine	Cadmium Lithopone King's Yellow
Class III.	None	None	All
Class IV.	Lampblack Ivory Black Graphite	None	All others
Class V.	None	Madder Lakes	All others

So much, then, for the materials employed in fresco painting; it would be beyond my scope to discuss in detail the preparation of the plaster and the laying on of the pigments, but I would like to refer briefly to certain technical aspects of the process. In the first place, all writers on fresco insist, and rightly insist, on the importance

utmost importance. To make sure of this, it was a perfectly sound practice to mature the slaked lime in olden days, when mixing had to be done by hand, and no means were available of reducing the lime to a uniformly fine powder. But I am convinced myself that more thorough and better slaking could be obtained in a

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comparatively short time by mechanical means; there is no reason why the slaked lime should not be matured by grinding it in water for a few days in a ball mill (a rotating cylinder filled with steel balls), when every particle would inevitably be brought in contact with the water, and a far finer and more uniform product obtained. Still more important is it to bear in mind that such mechanical slaking obviates all risk of partial carbonating of the lime-putty before use, which is liable to occur when it is kept for a prolonged period in the open. From the description given of the chemical action involved in the process it will be seen that any such carbonation would seriously weaken the plaster and result in the pigments not being firmly secured to the surface.

The composition and purity both of the lime and the "aggregate" or inert material added to it, again, are of importance, a point that is little realised by artists—for example, an excessive content of magnesia in the lime would impair its durability; in the execution of an important work it is well worth while to ascertain the composition of the lime used, and to know exactly what one is working with.

Although it is impossible to remove a pigment once put on, one pigment can be painted over another as long as the plaster is fresh, that is, before the carbonation of the surface has proceeded to any extent and an ample supply of solution of hydrate is available, to soak through the pigment and act as a binding agent. A certain amount of painting can also be done after the plaster has dried by saturating it afresh with lime-water and painting with pigment mixed with lime-water. Work can, in fact, be executed entirely in this way, a modification of the process occasionally employed by mediæval painters under the name "fresco-secco." This method is not, however, to be recommended for general use, as it is impossible to secure quite such thorough incorporation of the pigment with the ground by its means.

There can be no doubt as to the charm of a painting properly executed by this fresco process. It cannot be denied, however, that to modern ideas it is by no means an easy process to work in. The need for careful preparation of the design beforehand, so that the actual execution of the painting may be carried out with the necessary certainty and directness, the difficulty of preparing the painting surface from day to day and skilfully masking the necessary joints between one day's work and the next, the allowance to be made for the general lightening in tone of the pigments in drying—all these limitations are irksome to the modern artist, accustomed to the facility of painting in oil, and they demand for their successful solution a skill and craftsmanship which can only be attained by patient labour and the skill born of experience and practice—practice which, unfortunately, is difficult to attain at the present time, when commissions for fresco are few and far between.

These difficulties are, however, only matters of experience, and can be quite overcome by sufficient practice. But, apart from these limitations of technique, one also has to face the economic difficulties of fresco painting, the fact that the work must be done entirely on the spot, and the building must be at the disposal of the artist for a prolonged period serves, perhaps, more than anything else, to limit the opportunities for fresco painting, for under the modern conditions it is not always possible to segregate even a new building from its use for the necessary period. One might, however, hazard the suggestion that even in such cases the artist might sometimes profit by the example of the fresco painters of the days of King Minos, executing the work in framed panels which could be set into the wall bodily. Here, again, is scope for development and for co-operation between artist and chemist.

The most vital point to consider, however, is the question of the durability of fresco under modern conditions of exposure. There can be little doubt that under normal atmospheric conditions fresco is the most durable process of decoration imaginable. The pigments are of necessity limited to those which are practically imperishable, and a well-prepared plaster is proof against extremes of heat, cold and damp, which rapidly destroy any organic medium; there is little doubt, in fact, that the process was evolved as a means of protecting buildings against the disintegrating effect of weather, and the frescoes of the palace of King Minos, where preserved from the disastrous effect of the conflagration in which the building perished, have come down to us intact after some 3,000 years of exposure.

There is no doubt, moreover, that in ancient times, when fresco painting was the ordinary method of house decoration, the paintings outlasted their use, for it is quite a common thing to find the wall surface re-decorated, the surface being hacked over to provide a key, saturated with lime-water and a fresh layer of plaster added. I have found examples of this in all periods, the point being that the underneath painting is in quite a fair state of preservation,

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the only possible explanation being that it was covered, not because it was decayed, but because the occupiers of the house were tired of the design and wanted a fresh scheme of decoration. This practice was so common in this country in Roman times that examples of it are to be found in almost every museum. In the museum at Colchester, for example, are to be seen a number of specimens of fresco painting discovered in the ruins of a Roman villa, many of which exhibit three and even four paintings super-imposed in this way.

It is a great mistake to suppose, as many do, that the natural climate of this country is destructive to fresco painting. Unfortunately one must at the same time admit that the atmosphere of our modern towns in its present condition is extremely injurious to such work, for fresco has an extremely weak point—it is affected by the slightest trace of acid. This fact will be readily appreciated if you bear in mind the readiness with which the carbonic acid is removed from its combination with the lime, owing to its gaseous nature; a removal that is accomplished not only by heating, but by the action of any acid that is stronger than carbonic acid; such a substance, for example, as sulphuric acid, which decomposes carbonate of lime rapidly, driving off the carbon dioxide and combining with the lime to form gypsum. When this action takes place on the surface of a fresco painting decay inevitably results, because not only is the binding between the particles of pigment destroyed, but the whole substance of the plaster is gradually disintegrated. Now the atmosphere of our modern towns is heavily

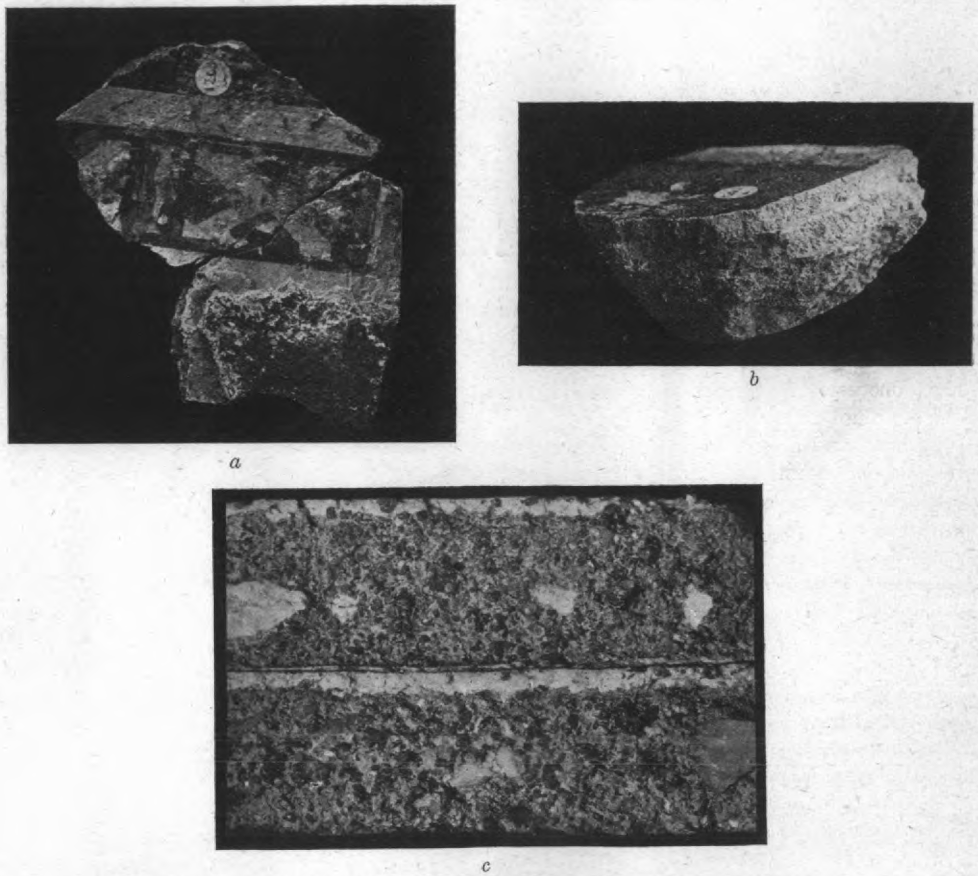

FIG. 2.—FRAGMENTS OF RANAN FRESCO IN COLCHESTER MUSEUM.

a. Fragment with top layer of plaster partially removed, showing the painting underneath in good preservation.
b. Side view of a fragment showing four layers of plaster super-imposed.
c. Section of *a*, enlarged four diameters, showing the structure of the plaster.

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charged with sulphuric acid as a result of the continual combustion of coal. It will be well understood, therefore, that apart from the concomitant evil of smoke, which rapidly covers a porous surface like fresco with grime and obscures its beauty, the effect of this contamination of the atmosphere is disastrous, and renders some protective after-treatment an imperative necessity, if durability is to be secured. The difficulty is to find any method of treatment which will effectually protect the surface from the action of the acid whilst preserving the inimitable quality of the painting, which is destroyed by any treatment such as sizing or varnishing, apart from the fact that these prove very inefficient for the purpose. Fortunately we have one method of preservation which to a large extent combines the maximum of protection with the minimum effect on the quality of the surface, and that is the encaustic process introduced by Sir Arthur Church in connection with the restoration of the frescoes in the Houses of Parliament. The treatment is carried out by covering the surface with a mixture of one part of hard paraffin wax with four parts of toluol, in the form of a kind of paste or ointment, and afterwards, when the volatile tuluol has evaporated, driving in the residual paraffin by means of heat. Of course this impregnation process is not a matter for unskilled hands; some care and experience is required for its proper performance.

This treatment is but a palliative; it inevitably entails some disadvantage, and under normal conditions fresco is better without it. But we must frankly realise that under modern conditions we have to face a choice of two evils—gradual but sure destruction, or a slight loss of quality, and the necessity for periodical cleaning to remove the dirt which adheres to, but does not penetrate, the waxed surface. I am strongly of the opinion myself that every fresco painting executed in this country should be subjected to this treatment, even in rural districts, for we must bear in mind that, although the vast bulk of impurity is produced in the large towns, it is distributed over wide areas by the movement of the air, and every little village, moreover, is a local source of contamination, so that one has to be remote indeed to obtain a perfectly pure air.

Let us now consider the possibility of modifying the process of fresco painting so as to overcome these limitations of durability. As far back as 1825 Fuchs proposed to anticipate the action of the sulphuric acid, as it were, by attacking the carbonate of lime directly it was formed, and deliberately changing it into another compound which could resist the action of sulphuric acid. This was accomplished by means of the chemical reaction expressed in the diagram:—

$$\text{Water Glass}\left\{\begin{matrix}\overbrace{\text{Silica}\qquad\text{Lime}}^{\text{Silicate of Lime}}\\ \underbrace{\text{Soda}\qquad\text{Carbon Dioxide}}_{\text{Carbonate of Soda}}\end{matrix}\right\}\text{Plaster}$$

The substance known as water-glass, because it has all the appearance of glass but is soluble in water, is prepared by combining soda and sand by heating them together in a furnace; when a solution of this substance is applied to the surface of a lime plaster, a mutual exchange takes place, with the result that a new substance—silicate of lime—is produced, which acts as a binding agent for the pigments, and has the advantage that it is proof against attack by sulphuric acid. Unfortunately we have to bear in mind the fundamental law of Lavoisier, on which the whole science of chemistry is based: matter is indestructible, and every particle of a substance taking part in a chemical reaction must be accounted for. We have to reckon, then, with the soda, which was combined with the silica we wanted, in order to render it soluble in water and available for attacking the plaster; discarded after having served its purpose, it combines with the carbon dioxide to form carbonate of soda, which must be entirely removed to render the operation a success, for if it is left in the plaster it is certain to cause unsightly efflorescence by crystallising out on the surface, and moreover is liable to attack the plaster again, causing a reversal of the action, the remedy being thus worse than the disease. The entire removal of this substance is, however, a very great difficulty, and its presence is sufficient to render the treatment in this form a failure.

But from this method of treating the plaster there has been evolved the process of *stereochromy,* which is not so much a modification of fresco as an entirely different process, entailing a different although similar technique and method of working. The stereochrome process was first employed in this country in the later decorations of the Houses of Parliament, after fresco had been abandoned on account of the difficulties encountered in its execution, due to lack of technical knowledge. The best-known examples are the immense paintings by Maclise in the Royal Gallery—the famous "Meeting of Wellington and Blucher after Waterloo," and the "Death of Nelson," and the painting by

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Herbert, "Moses bringing the Tables of the Law." These paintings were, however, by no means a perfect success—restoration was necessary within ten years of execution and further restoration was carried out at intervals. In 1894 Sir Arthur Church found them obscured in many places by an efflorescence of sulphate of soda and lime, indicating that the main cause of the trouble was the difficulty of removing all traces of alkali from the painted surface.

[Slides of the paintings referred to, and other modern examples, were here thrown on the screen.]

The original stereochrome process employed in the production of these works was considerably improved by Keim some time later. A full description of this process was given in this room some years ago,* so it is unnecessary to describe it in detail.

A painting of extreme durability is produced by the process if the cycle of operations involved in this process is carried out properly, as the final plaster is not only unaffected by acids but is extremely hard, and only slightly absorbent. Although this process has the added advantage over fresco that the preparation of the ground, the fixation of the pigments and the actual paintings are divided into three distinct operations, the execution of a large painting is, nevertheless, an arduous undertaking, on account of the numerous operations involved, and the difficulty of removing all traces of the soda, by laborious spraying with distilled water, an operation on which, as already explained, the success of the painting to a large extent depends. This process, in fact, is essentially a case for division of labour, the artist requiring the assistance of a highly-trained craftsman, preferably with some scientific knowledge, to ensure the success of the preparation and treatment of the ground.

We may ask, however, whether it is not possible to modify the composition of the plaster in fresco painting, so as to retain the comparative simplicity of producing the finished painting in one operation, without the necessity of subsequent spraying, whilst at the same time obviating the dangers inherent to carbonate of lime plaster. If one could obtain, for example, a brilliant white plaster with a composition resembling that of a slow-setting Portland cement, the difficulty would be solved; but this is not possible in the present state of our knowledge. There are, however, very great possibilities in the use of a cement of an entirely different description, depending on a curious reaction that takes place when oxide of zinc is mixed with a solution of chloride of zinc. If these two substances are mixed in the right proportions, they combine together slowly to form a substance known as zinc oxychloride, the composition being intermediate between the two, and in so doing set into a hard mass, thus forming a durable cement, which is largely utilised for many industrial purposes. Such a cement is not decomposed by sulphuric acid like carbonate of lime plaster, for the reason that it is a compound of an acid equal to it in strength.

There seems no reason why a process of painting which would bring fresco into line with modern requirements should not be based on this reaction, if only the opportunity for the necessary systematic investigation were forthcoming, and I venture to suggest that so far from fresco painting being a dead letter, as is so often suggested, the possibilities in the way of development in this direction which have never been exploited are sufficient to justify the hope that it may become once more—even under present conditions—the most durable as well as the most beautiful process of painting.

* This *Journal*, December 4th, 1895. I am indebted to Mrs. Lea-Merritt for much information on the practical working of this process and assistance in the preparation of the lecture.

THE TURTLE INDUSTRY OF MEXICO.

The rivers and fresh-water lagoons at some distance from the Mexican coasts literally swarm with turtles of the genus "Nanemys." They are found even at an altitude of about three thousand feet above sea-level. They attain a considerable size, some of them reaching a weight of sixty-five or even seventy-five pounds. This turtle is considered to be a dainty as well as a staple food all over the Gulf Coast region, and is annually taken in great numbers. According to the United States Consul at Vera Cruz, the supply seems to be increasing rather than diminishing. The wastes of water hyacinths are simply alive with the creatures, and while the tangle of the plants and roots makes fishing for them difficult, these places are becoming more and more the favourite localities for taking the turtles. In open waters they are caught with seines, but among the hyacinths recourse is had to the spear, as nets cannot be used advantageously. On account of the lack of shipping facilities the consumption of the turtle is restricted and largely local. It can, however, be easily transported. The turtles will stand shipment of several days by simply being occasionally doused with cold water, and arrive at their destination in a lively condition. Turtles of twenty-five to thirty pounds weight, sell

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in southern Vera Cruz towns for a sum equivalent to about 1*s.* 7*d.*; large ones sometimes bring as much as 2*s.* in the local markets. These turtles are fat and fine of flesh, and under careful handling would give a good return to the man who undertakes to ship them either to the markets in the interior of Mexico or to the United States. By arranging shipping boxes provided with a small tank for fresh water, in which the turtles could bathe, they could easily be put on the northern markets in prime condition, and just as good as when taken from the rivers. For shipping purposes only net-caught turtles should be handled, for speared turtles, though the wound may be slight, are liable to spoil, owing to the inflammation of the wounds. There is a small swamp turtle called "pochitoque," which is of extremely fine flesh and flavour. It is found in great numbers in the swamps and lands that are annually overflowed in the State of Tabasco, and is very similar and quite equal to the famous diamond-back turtle. This also could be readily shipped to northern markets. It is not quite so abundant as the river turtle, but would find ready sale at fancy prices in view of the diminishing supply of the diamond back. As it lives a good part of the year on the land the question of shipping would be correspondingly simple, and expenses less than in the case of the water turtles. These land turtles are annually destroyed in enormous numbers by fires, either accidental or intentional, which devastate the lowlands, and tens of thousands of them are left to rot when burned.

THE JAPANESE FRUIT INDUSTRY.

The principal fruits of Japan are persimmons, mikan (mandarines or Japanese oranges), pears, apples, peaches, grapes, strawberries, apricots, water-melons, figs, walnuts, and chestnuts. Apples are very popular in the country, and the history of Japanese-grown apples, as developed in the principal cities, dates back only a few years. Young trees were imported from America and planted in Hokkaido (northern island), and in the northern provinces of Akita, Aomori, and Yamagata. The experiment proved very successful, and about twelve years ago northern apples began to supply Tokyo and other large city markets in Japan. The people in general, however, have not yet learnt to use the apple or any other fruit in their common diet, its principal use being for afternoon tea, or for children, usually to be eaten between meals. Apple jam or other forms of cooked apples are almost unknown among ordinary Japanese families. As a rule apple-growing is considered as an incidental source of income among Japanese farmers. No statistics as to acreage, number of trees planted per acre, varieties, average yield, irrigation, etc., are available. The Oonshiu, or Satsuma, orange is grown in the southern and south-eastern parts of Japan, the northern prefectures and the western coast being too cold. Oranges, according to the American Consul at Kobe, are grown chiefly at an altitude of six hundred to two thousand feet above sea level. A southerly exposure is best for the tree, and the best soil is a sandy loam with gravel about three feet from the surface. The land should be hilly and rolling. The most favourable temperatures range from 36° to 95° F., with an average of 65°. It is uncertain what degree of cold the Satsuma orange can stand without being killed, but at Wakayama, with a temperature of 22°, no trees have been reported killed. Strong gales, especially sea winds in summer, cause the leaves to wither, and are generally considered worse for the trees than cold weather. In the more northerly districts where oranges are grown the trees are sometimes covered with coarse matting in winter. It is impossible to state accurately the age that Oonshiu oranges will attain, as there are no records of the dates of planting of the very old trees. There is a tree about one hundred and fifty years old in Kamomura, Wakayama Prefecture, whose trunk is over four feet in circumference near the roots. A tree at Takatamura, Kumamoto Prefecture, is said to be the oldest in Japan. Up to ten years ago its branches had a spread of sixty feet radius in every direction, but they are now reduced to an east and west diameter of twenty-seven feet, and a north to south measurement of one hundred and eight feet. Roots have grown from the branches of this plant, which lie on the ground. Oranges were formerly grafted on the Yudsu (*Citrus aurantium*), but now the Kikoku (*Citrus fusca*, or *Citrus trifoliata*), which is much hardier, is widely used. Grafting on trees is commonly done without removing them from the ground, but sometimes the trees are dug up, grafted and transplanted. Budding is a new system in Japan, but it is gradually being widely adopted. The Oonshiu orange tree usually grows ten or twelve feet high, covering a space twenty-two or twenty-three feet in diameter. It branches close to the ground, and not being pruned the weight of the fruit causes many branches to lie on the ground. The Japanese prefer a low tree, as the fruit can be picked without ladders and the branches keep the ground cooler and more moist than it would be if exposed to the sun. The recent progress in fruit culture in Japan has been very striking, it being now considered as a far more profitable occupation than ordinary farming, and it is also considered to be superior to the ordinary laborious work of tilling. The result of this is that the better class of farmers are now engaged in it. At one time orchards were found only in places adjacent to large towns, but at present orchards of oranges, peaches, apples, etc., are found in remote places. Hills are now extensively opened up to lay out orchards, and places favourably situated command, in fruit districts, astonishing prices. Generally speaking, apples are grown in Hokkaido and Aomori; peaches near Tokyo and in Okayama; pears in the suburbs of Tokyo, in Saitama, Niigata, Nara, Chiba; grapes in Yamanashi, Tochigi, and Niigata; oranges in Wakayama and in Southern

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Japan. Persimmons may be said to grow everywhere. Cherry trees are prized more for their flowers, and their fruits are therefore altogether secondary. Foreign cherry trees are cultivated in Yamagata.

EMPIRE NOTES.

Canada and Labour Disputes.—The Canadian Act for dealing with industrial troubles connected with "Public Utilities"—that is mines, railways, engineering, and other large industries—appears to have worked well during the five years in which it has been established. The main principle of the Act is compulsory investigation, with the view of bringing about voluntary conciliation and arbitration. It requires that any cases of dispute arising between an employer and his employees, which may be of sufficient importance to justify State interference, should, before it is allowed to issue in a strike or lock-out, be submitted to a board, which has power to require the attendance of witnesses and to investigate fully the causes of such disputes. The *Official Labour Gazette* of Canada, in reviewing the proceedings under this Act, says that "during the five years the Industrial Disputes Investigations Act has been in operation, 124 applications have been received for the establishment of boards of conciliation, the result of which has been that 110 boards were established, and in the fourteen remaining cases the matters in dispute were adjusted by mutual agreement. In ninety-three out of the 110 cases referred for investigation, the inquiry resulted either in a direct agreement between the parties, or in such an improvement of relations as led to the settlement of the dispute." This is a very satisfactory statement, and may indicate the course that should be adopted in this country. In any case, if investigation can be made prior to a threatened strike or lock-out, it were better than investigation and an attempt at conciliation after the strike or lock-out has been declared. In the former case the chances are that when the causes of the dispute have been ascertained, the parties to it may far more easily be brought together and the differences between them adjusted. The only compulsion used in the Canadian Act applies to the preliminary inquiry. When that is concluded, and the effort at conciliation resulting from it has been made, the further steps that may be taken are left to the parties, who are free then, if they so desire, to carry their dispute to the arbitrament of industrial war, but not till then.

The Cost of Living in Australasia.—Last year the Commonwealth Statistician published a return as to the cost of living for the twelve-monthly period July 1st, 1910 to June 30th, 1911. Copies of small account-books had been distributed among 1,500 householders throughout the Commonwealth, in which provision was made for weekly records to be kept of all receipts and expenditure. Of the 1,500 to whom the books were sent, 212—including 107 with over four members, and 105 with under four members per family—furnished the required particulars. The number of children recorded was 522, or an average of 2·46. New Zealand, desiring to obtain similar information, issued 2,000 books for records to be kept from October 1st, 1910 to September 30th, 1911. Of this number only sixty-nine families—including twenty-six with over four members, and forty-three with under four members —furnished the required particulars. The children numbered 160, or an average of 2·32 per family. From so small a proportion of returns received, no complete statement of the cost of living can be deduced either for the Commonwealth or New Zealand. Nor can a full comparison of the relative cost of living as between the two countries be deduced, as the Australian inquiry included country as well as town workers, while the New Zealand inquiry was for town workers only. Some very useful information has, however, been obtained, which will, doubtless, lead to the creation of a wider public interest in the subject, and to the organisation of a system of inquiry which will secure fuller and more adequate returns. From the particulars recently published by the New Zealand Department of Labour, it appears that the four main items of expenditure dealt with housing, food, clothing, and fuel and light. The returns show that the worker with no family spends very nearly the same sum weekly on food, but saves in rent, clothing, and other items; and at each week-end has a surplus of 1*s.* 9½*d.* Apparently, he buys more luxuries, in the way of food, than his co-worker who has a family, and his average expenditure on clothing is also higher. The family man pays 5*s.* more rent per week, 8¾*d.* more on food, 1*s.* 1¾*d.* on clothing, and 3*s.* 3½*d.* on other items. His fuel and light expenses, however, are relatively lighter to the extent of 1*s.* 4½*d.* per week. This worker, however, has no surplus at the week-end. The figures generally indicate, as may be expected, the favourable position, as far as expenditure is concerned, of the families possessing few, if any, children. The New Zealand returns show, as do the Australian, that the cost of food is by far the most important factor, amounting to nearly 34 per cent. of the total expenditure. Next comes housing, 20·22 per cent.; then clothing, 14·47 per cent.; and fuel and light, 5·20 per cent. In respect to alcoholic liquor, no less than thirty-nine out of the sixty-nine returns received, or 56 per cent., are from teetotal families. The average expenditure per week of the thirty non-teetotal families is 9½*d.*, as compared with the general average for the country of 4*d.* The average weekly expenditure on tobacco and cigars is shown as 7½*d.*; but, excluding twenty-six non-smokers out of the sixty-nine, the average is 1*s.* Six families only gave their expenses as "nil" for "sports and amusements," the average all round being almost 1*s.* per week. Friendly society and trade union contributions were paid by 63 families, an average of 91 per cent. Medical expenses averaged 1*s.* 1*d.* per

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family; and all, excepting eight families, showed expenditure under this heading. The average expenditure for rates and taxes was *5d.* Many other particulars are given in the report of the New Zealand Department of Labour, as well as a complete table of the prices of commodities, from which it may be seen that the prices of the staple articles of food compare favourably, in some instances very favourably, with those in the United Kingdom.

New Zealand's proposed Honour to Wakefield.—Fifty years ago, Edward Gibbon Wakefield, to whom New Zealand and the Empire owe so much, died in Wellington, and at last the country which he served so well is about to honour his memory. On this subject the *New Zealand Herald* says:—"As yet, no public monument or memorial has been raised to the man who rendered such conspicuous service to the cause of colonisation, and who is rightly regarded as the real founder of the colony of New Zealand. Happily, this reproach will shortly be removed. It is, indeed, remarkable that so great a man should have found such small honour in a State which owes its very being to him. His name is seldom heard, his labours forgotten. He rests in a grave which only the curious know or care to visit. Wakefield, a compound of paradoxes, has achieved the great paradox of life: a success so complete and lasting that the world forgets he ever fought. It is, however, time our national conscience pricked us. No lapse of years can bar the debt we owe to Wakefield, and common gratitude should urge us to make some public acknowledgment of it which will keep his memory fresh among us, and prompt, perhaps, later generations to read the story of a life devoted to the advancement of the public good; for, while Wakefield has a just claim to fame throughout all the Oversea Dominions, he has a special and peculiar title to public recognition in New Zealand." The proposal to honour Wakefield's memory, in the way indicated in this article, will be appreciated by many in England who know something of the work done in the cause of Empire by this remarkable man, and by none more than by Sir Frederick Young, who was his coadjutor in the early days of emigration to New Zealand, and who himself has done a great deal to promote the progress and the unity of the Empire, and still lives to mark the advance of those great Imperial interests for which Wakefield toiled and suffered.

An Australian Motor-car Invention.—By an adaptation of the famous "stump-jump" principle, which has done so much for Australian agriculture, an inventor has made it possible for the motor-car to be used on the roughest of roads and tracks with ease and comfort, and to be run at a high rate of speed. What this will mean to the traveller in the Australian bush only those who know the conditions obtaining in that country can fully appreciate. The inventor is Mr. T. T. Charley, and his invention is known as "Charley's Equipoise Suspension." The body of the new car is made to rest on four vertical spiral springs, one on each short axle that supports each wheel. By this arrangement the shock that a wheel sustains, when it strikes an obstacle of any unevenness in the road, is transmitted to horizontal spiral springs, running fore and aft on the car, and then connected with the vertical spring on the hind wheel. So sensitive is the transmission that almost immediately one wheel strikes the obstruction the other is affected, thus giving the minimum of shock as the wheel lifts, immediately the obstacle is struck or an uneven road is traversed. No shock is, therefore, felt by persons in the car. The tyres used in the construction of the new car are simply iron bands fixed to the rim of the wheel, with a band of solid rubber vulcanised to the outside, about an inch in thickness. These tyres are said to be good for 10,000 miles running, the rubber being used chiefly to deaden the sound. By this arrangement, which can be applied to any ordinary motor-car, the pneumatic tyre is rendered unnecessary. In order to test the value of this remarkable invention, the members of the Australian Northern Railways Commission were invited to take a run in the car, and were driven over a road that would be almost impassable in an ordinary car at a high rate of speed. They went over two deep spoon-drains (the dread of motorists) at about twenty-five miles an hour, yet the shock was scarcely felt by the passengers. The opinion of the members was that the invention has a great future, as it certainly should have, if, on further proof, it be found to accomplish all that is now claimed for it.

The Future of the Dominion of Canada.—In an address recently delivered in this country, the Hon. G. E. Foster, Minister of Trade and Commerce in Canada, made a striking statement as to the present resources and future prospects of the Dominion. Referring to the question of grain production, he stated that last year 180 million bushels of wheat had been harvested in the Prairie Provinces alone, and that to convey this produce to market all their facilities of rail and water had failed to meet the demand for transport. What, then, was the future of Canada likely to be in the development of its transport resources alone, when the whole of the country was made available for cultivation instead of a small percentage, and was brought into productive use? Then as to population, to-day, he said, they had seven millions of people. Last year they received 354,000 immigrants. This year the number would be 400,000. They might, he continued, regard it as a reasonable estimate that for the next fifty years there would be an increase by immigration of at least 500,000 people per year. If to this be added the natural increase, Mr. Foster estimates that in fifty years the population of Canada should be close on 50 million people! He therefore concluded that the coming fifty years would witness a far larger development than the past fifty years had seen. In proof of the present

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advance of the material prosperity of the Dominion, recent returns show that trade is increasing at the rate of nearly 20 million dollars a month (£4,109,598), while the final results for the past fiscal year show a surplus of about 38 million dollars (£7,808,219) over all ordinary expenditure. It is indeed difficult to estimate what will be the development of a country if its advance in population and trade is maintained on lines proportionate to those of the past few years.

CORRESPONDENCE.

PAPAYA OR PAWPAW.

Referring to the note in the *Journal* of the 2nd inst., on the "Papaya or Pawpaw," by our member, Captain R. C. R. Owen, Governor of the Mongalla Province of the Sudan, I may at once state for his information that its properties of rendering meat tender have been known in India almost from its first introduction there by the Portuguese from South America; and have in our own day been made widely known through the writings of Sir William Henry Sleeman, the Rev. Dr. Francis Mason, and the Rev. Alexander Kyd Nairne; to say nothing of official reporters on the commercial products of India,—of whom Sir George Watt is the head and front of all of us. His great "Dictionary of the Economic Products of India" ought to be placed by the Imperial Government in the hands of every British administrator throughout our tropical and sub-tropical possessions.

In the *Journal* of March 1st last, I dealt only with the etymology of the word "pawpaw," its Cuban name,—? from the *Carib ababi*,—rendered *papayo* by the Portuguese, and *papai* by the people of India—of the plant, the Carica Papaya of Linnæus. Meat of any sort wrapped up in its large castor oil-like leaves [it is a "Passion flower"], or placed beside its fruit, or hung in the shadow of its palm-like head of leaves and fruits, rapidly becomes tender; while the flesh of fowls fed on its seeds seems as if digested alive by them to the mollisity of a *mousse* at the Dieudonné. The fruit cooked is a good substitute for apples—stewed, or as boiled dumplings, or baked pies—and seems to have digestive virtues; the seeds certainly have. They are pungent, with something of an ethereal flavour added; and dried and pounded are an excellent substitute for pepsine; and innocent of all taint of slaughters that must, in consideration of their needlessness, be accounted, each one of them, as foully murderous as the offerings passed through the fires to Moloch.

GEORGE BIRDWOOD.

NOTES ON BOOKS.

ENGLAND'S INDUSTRIAL DEVELOPMENT. By Arthur D. Innes. London: Rivington & Co. 5*s*.

The author states in his preface that it has been his object to provide for the ordinary reader a "concise historical survey of the Development of Industry and Commerce in England," and he may certainly be given the credit of having succeeded. As he begins with the Roman conquest of Britain, and ends with a reference to the industrial difficulties of last year, it cannot be said that his survey lacks completeness. Indeed, he treats his long period of two thousand years with commendable skill, and compresses into the 374 pages of which the book consists a vast amount of information of a sort not to be found in ordinary historical text-books.

His treatment of the subject is throughout that of a student of economics; the scientific and technical side of industrial history is passed over—one hardly likes to say neglected—but where any technical or scientific details are included, they are, so far as can be judged from a cursory perusal of the book, correctly given, and this is something to be thankful for. The work is divided into three parts —"The Middle Ages," "The Mercantile Period," and "The Industrial Era." The first two parts may be looked at as introductory to the third, and give us in a concise but quite interesting shape the economic and commercial history of England down to, say, the American Revolution, or, as we might prefer to date it, the completion of the steam engine. To many readers these first two parts of the book may very probably be the most interesting, and they may be commended to all who care to study other details of the history of their country besides its battles and the adventures of its monarchs. The third part, which deals with modern industrial England from the industrial revolution to the present time, is an excellent and compendious account of the economic, financial, and commercial history of the country during that period. It includes chapters dealing with the Poor Law, Laissez Faire, Free Trade, the Factory Acts, Trade Unions, and other subjects, including the various attempts to regulate and improve industrial conditions by legislation. Perhaps some day somebody will write a history of the influence of science upon industry, and such a work will provide Mr. Innes's excellent treatise with the complement it requires.

GENERAL NOTES.

SCHOOL OF ART WOOD-CARVING.—At the recent National Competition one student of this school was awarded a gold medal, a second received National Book Prizes, while a third was commended.

THE PRODUCTION OF EDIBLE TUBERS IN MEXICO.—The chinchayote is the tuber of a gourdlike plant grown in the State of Guadalajara, whose botanical name is *Sechium edule*. The year-old tubers are boiled and candied, and are sold by street vendors, being very popular among labourers and children. The larger two-year old tubers are sliced and fried for table use. The tubers yield an excellent starch,

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similar to arrowroot or sago. Above ground the chinchayote is similar to a gourd plant, with a smaller leaf, and the flower develops into a bulbous fruit covered with prickly spines called the chayote. The tubers are the part known as the chinchayote, and these resemble a sweet potato in shape, the colour under the skin being white. Each plant produces ten to thirty tubers, having a total weight of five to thirty pounds, varying with age, as some plants are allowed to grow for two years, producing larger and more numerous tubers. For cultivation the chayotes are sprouted in a moist place, and then planted sometimes three plants together. The planting season, according to the American Consul at Guadalajara, is from February to April, and the plant requires little attention thereafter. The chayotes or fruit are gathered in September or October, and the chinchayotes or tubers mature from October to December, being taken up when they reach the desired size. The shrubs are planted seven to ten feet apart, loose soil that has been used for other crops being the best.

Liquid Fuel for the Navy.—The King has been pleased to approve of the appointment of a Royal Commission to report on the means of supply and storage of liquid fuel in peace and war, and its application to warship engines, whether indirectly or by internal combustion. The following will be the members of the Commission:—Admiral of the Fleet the Lord Fisher of Kilverstone, G.C.B., O.M., G.C.V.O. (Chairman); the Right Hon. George Lambert, M.P.; Sir Boverton Redwood, Bart.; Sir Philip Watts, K.C.B., F.R.S.; Engineer Vice-Admiral Sir Henry John Oram, K.C.B., F.R.S.; Vice Admiral Sir John Rushworth Jellicoe, K.C.B. K.C.V.O.; Sir William Matthews, K.C.M.G.; Sir Thomas Henry Holland, K.C.I.E., F.R.S.; Sir Thomas Edward Thorpe, C.B., F.R.S.; Alexander Gracie, Esq., M.V.O.; Humphrey Owen Jones, Esq., M.A.; and Alfred Fernandez Yarrow, Esq.; Captain Philip Wylie Dumas, C.V.O., R.N.; Engineer-Lieutenant Charles John Hawkes, R.N., and John Harper Narbeth, Esq., M.V.O., Royal Corps of Naval Constructors (joint secretaries).

Commerce of Patras.—The trade of Patras, stimulated by the exceptionally good harvests of the last two years, has been very satisfactory of late. Amongst the principal imports, which include manufactured goods of every description, corn, sugar, etc., salt codfish from Newfoundland takes a prominent place. It is largely consumed by the Greek peasantry. During the two months ending December 31st, 1911, no less than 34,781 quintals (68,466 cwts.) of this commodity were landed at Patras. Two lines of Liverpool steamers touch at Patras regularly every fortnight bringing a quantity of English goods, which are forwarded from thence to other towns inland. The principal exports from Patras consist of currants, olive oil and preserved olives, dried figs, wine and tobacco, which is extensively grown in the district; this is chiefly exported to Germany and Holland.

Market-gardening in Lombardy. — Some recently published official statistics give some interesting information respecting market-gardening in the Province of Milan. The total area cultivated for the supply of vegetables in this district is 1,059 hectares (2,615 English acres), of which 505 hectares (1,247 acres) are situated in the immediate vicinity of Milan. The total gross value of the produce of these 1,059 hectares is estimated at 6,885,000 lire (£275,000) annually. The following is the average yield per hectare and in acres of some of the principal crops:—

	Per hectare.	Per English acre.
Cabbages	35,000	14,175
Celery	110,000	44,550
Small marrows	50,000	20,250
Radishes (no. of bunches containing 18 in each)	12,000	4,860
Lettuces and small salads	90,000	36,450
	quintals	cwts.
Tomatoes	280	551
Potatoes	135	266
Asparagus	45	88
Carrots	100	197
Beetroot	200	394
Turnips	160	315
Spinach	60	118
Onions	125	246
French beans	40	79

The average gross yield is valued at 9,000 lire per hectare (£145 8*s.* per acre), in the neighbourhood of Milan, per annum; at 4,000 lire (£64 8*s.*) near other towns in the province, and at 2,500 lire per hectare (£40 9*s.* 7*d.* per acre) in the rural districts.

Production of Wine in Turkey.—The production of wine in Turkey is an industry capable of great development, especially in Syria, Palestine, Smyrna and Salonica. The total quantity of wine made in 1910 is estimated at 100,000 tons (about 220,000,000 gallons), the greater part of which was consumed in the country and in Egypt. A considerable quantity of red and white wines were also exported to Germany, France and America. Wine is also one of the principal articles of export from Jerusalem to the United States.

Italian Trade at Stavanger.—The trade between Italy and Stavanger does not as yet appear to be of much importance, but according to the report of the Italian Consul at that port it shows a tendency to increase. This is due to the establishment of a direct line of steamers (Norwegian) between Stavanger and Italy. The exports to Italy last year consisted principally of 1,250 cases of sardines, 6,903 deal boards for making packing-cases, and about 1,167 tons of old iron. On the other hand, Italian produce seems to be more in demand, and included 520,550 kilogs (1,147,812 lbs.) preserved tomatoes, 475,800 kilogs (1,049,134 lbs.) olive oil, twelve casks of wine, 236 bales of hemp, 457 slabs of marble, lemons, almonds, etc.

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Journal of the Royal Society of Arts.

No. 3,117. VOL. LX.

FRIDAY, AUGUST 16, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The results of the Elementary Examinations (Stage I.) have now been issued. The results of the Intermediate Examinations (Stage II.) were published on July 15th, and the results of the Advanced Examinations (Stage III.) on June 15th.

The programme for 1913, containing the previous year's papers and the examiners' reports on the work done, will be published in September.

The time-table for 1913 is as follows:—

ROYAL SOCIETY OF ARTS EXAMINATIONS, 1913.

	Monday, April 7 (7–10 p.m.).	Tuesday, April 8 (7–10 p.m.).	Wednesday, April 9 (7–10 p.m.).	Thursday, April 10 (7–10 p.m.).	Friday, April 11 (7–10 p.m.).
Advanced Stage.	Book-keeping. Précis-writing. Economics. Danish and Norwegian.	Arithmetic. Commercial Law. German. Italian. Spanish.	French. Commercial History and Geography. Typewriting (7.30 to 10 p.m.).	Accounting and Banking. Shorthand (140 and 120 words per minute) (7.15 to 10 p.m.).	English. Portuguese. Russian. Swedish. Chinese. Japanese. Hindustani.
Intermediate Stage.	Typewriting (7.30 to 10 p.m.). French. Danish and Norwegian. Commercial History and Geography.	Book-keeping. Précis-writing.	English. Economics. Spanish. Commercial Correspondence and Business Training.	Arithmetic. German. Portuguese. Italian. Russian. Chinese. Japanese. Hindustani.	Swedish. Shorthand (100 and 80 words per minute) (7.15 to 10 p.m.).
Elementary Stage.	Handwriting and Correspondence. French.	Commercial Geography. Typewriting (7.30 to 10 p.m.).	Book-keeping. Spanish.	Shorthand (50 words per minute) (7.15 to 10 p.m.).	Arithmetic. German. Italian.
Music.		Harmony.	Rudiments of Music (7 to 9 p.m.).		

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE MATERIALS AND METHODS OF DECORATIVE PAINTING.

By Noel Heaton, B.Sc., F.C.S.

Lecture III.—Delivered April 1st, 1912.

Oil and Tempera Painting.

I pass on to-night to the consideration of the various methods of painting in which the pigments are not incorporated with the ground as in fresco, but fixed to it by means of a vehicle or medium. All such substances are organic in nature—that is to say, they are complex compounds of carbon produced by animal or vegetable growth, and, as we have already seen, the substances available for this purpose vary in their nature and properties, different methods of painting being based on the properties of different classes of compound.

First of all, we have substances such as gum, which are freely soluble in water, and which can be used as a vehicle in the form of a solution, the pigments being mixed with this in painting and fixed to the surface by the film of original gum left on evaporation of the water. Such a water-colour painting is, however, subject to destruction by moisture, and is quite out of the question for permanent painting.

Tempera Painting.

The first process we have to consider which fulfils the necessary condition of permanency is tempera, in which the binding agent is mixed with water for purposes of application, but has this difference as compared with distemper, that it becomes insoluble after drying, the painting being thus rendered permanent.

This result is generally obtained by the use of an *emulsion*, which may be described as a false solution, being only apparently soluble in water, consisting, in reality, of a substance insoluble in water but rendered capable of mixing with it by being broken up into minute particles, which remain in suspension. An oil, for example, can be emulsified by shaking it up vigorously in water in which some substance of the nature of glue is dissolved. The most familiar example of such an emulsion is milk, which has been used from time immemorial as an addition to size in distemper painting. The emulsion generally used in tempera painting is yolk of egg, which consists of globules of oil suspended in a solution of albumen. This is freely mixable with water, but although on drying the particles of pigment are at first only held by the albumen, and are consequently removable by washing, after a time the oil hardens (by a process to be described shortly), and binds the pigments more firmly, the painting becoming practically waterproof.

This medium was, as we have seen, largely employed in mediæval times for decorative painting.

In working in tempera it is decidedly best to paint on an absorbent ground such as plaster, the medium then sinking into the substance of the ground and keying the painting well on to it, instead of remaining on the surface, as is the case if a non-absorbent ground is used. It is true that it is more difficult to paint on an absorbent ground; but it can be done, and if durability is desired the difficulty must be surmounted.

Tempera painting can either be executed on the wall itself or on a separate ground, such as prepared panel, canvas or paper; in the case of the former the plaster should be plaster of Paris for preference, as this is not attacked by the sulphuric acid present in the air. If a painting is executed on lime plaster it is important to see that the process of conversion of the lime into carbonate of lime has completely taken place, as the caustic lime is destructive to the organic medium.

During recent years tempera painting has been widely used in ordinary house decoration, many mediums having been introduced for the purpose under the name of "washable distempers." Such mediums are, of course, proprietary articles, and one is not familiar with their exact composition, but, broadly speaking, they may be described as emulsions, similar in character to yolk of egg, but consisting of a vegetable oil such as linseed oil, suspended in a solution of size. The best of these products are excellent mediums, and there is no reason why they should not be employed for decorative painting on a large scale.

Amongst these washable distempers we find also in extensive use another medium which is essentially different in properties. This is not an emulsion at all, but depends on a different reaction for its binding properties. This is the albumen extracted from milk, used in mediæval times under the name of "cheese-glue," and generally known as casein. When milk is "de-emulsified" or "separated," to obtain the cream, the casein remains in the "skim-milk," from which it is obtained by the addition of acid which "curdles" the milk—that is, pre-

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cipitates the casein as a solid insoluble in water. In making cheese (which consists largely of casein) an organic acid (rennet) is used, but in preparing casein for industrial use the skim-milk is heated with hydrochloric acid, and the casein is thus prepared in immense quantities in the form of a granular powder. Casein, although itself insoluble in water, if treated with an alkali, such as soda, potash, ammonia or lime, forms compounds which are soluble in water. The compounds with soda and potash are of no particular advantage, but in the case of ammonia and lime the production of a tempera medium is rendered possible. If a painting is executed with such a solution as a medium it is rendered insoluble and waterproof on drying by the evaporation of the ammonia in the one case and the gradual conversion of the lime into carbonate of lime in the other, thus setting the original casein as an insoluble binding agent. The former method is somewhat objectionable, but the latter is perfectly practicable, and is, in fact, largely employed in the production of "washable distempers." For decorative painting, however, one is inclined to suggest the use of baryta water instead of slaked lime as the dissolving agent, as it is much stronger and absorbs carbon dioxide more rapidly than lime, so that the painting is rendered more quickly insoluble.

Casein painting, it will be noticed, has the great advantage over ordinary egg tempera that it can be employed on a freshly prepared lime-plaster with advantage; in cases where a newly-executed fresco painting requires a little subsequent alteration, "a secco," therefore, this is eminently the process to adopt. It must be remembered, on the other hand, that in casein painting one is limited as regards pigments to those that can be used in fresco painting, whereas in ordinary egg tempera many additional pigments, such as the more permanent colours in Classes IV. and V., are admissible.

All tempera paintings are liable to attack by moulds if allowed to become damp, which causes more or less rapid disintegration of the medium; but this may be to a large extent prevented, and the medium, moreover, rendered far harder and more insoluble by treatment, after the painting has been executed some days, with a 10 per cent. solution of formic aldehyde (formalin) applied over the whole surface with a soft brush, or by means of a spray diffuser.

Oil Painting.

We now come to the oil medium, which is quite different in nature from anything previously considered. In ordinary oil painting, of course, the pigments are merely ground in pure oil, the paint so prepared gradually hardening on exposure to the air, but remaining in a plastic condition for days, allowing the painting to be altered and repainted in a way that is impossible with any other medium. Moreover, the paints will keep indefinitely if preserved out of contact with air, so that they are generally prepared wholesale, and perhaps pass through two or three hands before they reach the artist, who very often is entirely ignorant of their nature and preparation.

These facilities are an undoubted advantage in many ways, although they are not without compensating disadvantages, which, however, it would be outside our present purpose to discuss. Oil painting is, however, the method of painting in general use at the present time, and the nature and technology of the method have been frequently explained, so that it is unnecessary to deal with it fully. I will merely remind you of the most important points concerning the nature of the medium. In the first place it must be understood that what is termed the "drying" of oil is essentially different in nature from the drying of distemper. For instance, the oil does not evaporate; on the contrary, there is more of it present after drying than before, for the process is really one of oxidation—that is to say, the oil, when exposed to the air, absorbs oxygen, and by so doing is gradually changed from a liquid to an elastic solid substance similar in nature to india-rubber. This peculiar property of "drying" on exposure to air is not a property common to all oils, but only to a few of vegetable origin, the most important of which are linseed oil, poppy oil, walnut oil, and tung oil. The first is the oil generally used in house painting, but the second, and sometimes the third, are used in the preparation of artists' colours, as they are paler and sometimes slower in drying.

It is important to understand clearly the nature of the drying action, because it is this very property which limits the durability of an oil painting. The process of combination with oxygen does not cease when the change to the solid state has been effected, but continues at a slower rate, with the result that the film of dried oil from being soft and elastic becomes harder and more brilliant, until finally it disintegrates entirely. The rapidity with which the change takes place, however, varies enormously according to the conditions of exposure. If an oil painting is

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directly exposed to fresh air and bright sunshine it will perish quite quickly, and more quickly the more fresh air and sunshine it gets, because under such conditions the oxidation is more rapid. When protected from the direct action of the atmosphere, however, by being placed indoors, and more particularly if sealed by a coating of varnish, this action takes place very slowly, and a film of oil paint is remarkably durable, provided that it is properly prepared and properly applied, so as to avoid any tendency to cracking and other defects.

The oil film, however, inevitably suffers this change sooner or later, becoming hard and brittle; also, as a result of this change, organic bodies of an acid character are produced which attack and weaken the ground to which the painting is attached. The oil film also darkens in colour considerably, as a result of exposure, with the result that the brilliancy of the painting is reduced and often entirely obscured.

There is a further cause of destruction in the case of oil painting, which should not be of any moment in the case of paintings executed on a ground such as canvas or panel, but becomes of importance in connection with its application to mural painting, and that is that whilst a drying oil is practically unaffected by acids, it is rapidly decomposed by alkalies, such as soda, potash or lime. This is due to a chemical reaction generally known as "saponification," the general nature of which is indicated in the diagram:—

$$\text{Vegetable Oil}\begin{cases}\overbrace{\text{Organic Acid}\qquad \text{Alkali } (\textit{Soda, Potash or Lime})}^{\text{Soap}}\\ \text{Glycerine}\end{cases}$$

The oil is a compound of glycerine, with a complex organic acid, with which the alkali combines to form the substance soluble in water familiar to us as soap, setting the glycerine free. Now glycerine, as is well known, is very strongly hygroscopic, and the result of this action is, therefore, that the film of paint gradually dissolves away entirely.

Now we have seen in our discussion of the nature of fresco painting that a freshly-plastered wall contains a large amount of caustic lime, which is gradually converted into carbonate of lime on exposure to the air. This caustic lime has all the properties of an alkali, and although, as we have noticed, the conversion commences immediately the plaster is laid on the surface, the amount of carbon dioxide in the air is small and the conversion of the entire substance of the plaster is a very lengthy matter indeed—in fact, in examining the ancient frescoes of Knossos, where a very great thickness of lime-plaster was employed, I found that a minute trace of caustic lime was still present in those portions furthest from the surface, after over 3,000 years' exposure.

Bearing this fact in mind, it is clear that if oil painting is to be applied to a lime-plaster wall, care should be taken to see that it is not only perfectly dry, but free from all traces of caustic lime. In the case of gypsum plasters, such as plaster of Paris, Keene's cement, Siraphite, and so forth, these remarks do not apply, as the setting is an entirely different process, no free lime being present. Dryness is, however, of importance even in this case, for if moisture be present when the paint is applied, it will, of course, tend to evaporate, causing blisters and breaking the oil film.

But, under any circumstances, an oil paint such as is used for pictures, although delightful to work with, produces a surface which is eminently unsuitable for decorative paintings; and it is necessary, therefore, if oil is to be used at all, to modify its composition. Many works have been executed with a medium consisting of oil to which a certain amount of paraffin-wax has been added, but although this produces a matt surface and the immediate result is so far satisfactory, the ultimate gain is questionable, as the medium is in a condition of instability, the wax tending to crystallise out from the oil. Moreover, such a medium is similar in its working qualities to oil paint, and the inevitable tendency is to work with it in oil technique, producing impasto effects which are objectionable in decorative paintings, both on the score of design and durability.

Oil Tempera.

The alternative method of producing a soft matt surface by reducing the oil to a minimum, merely sufficient to fasten the pigments to the ground, by diluting it largely with a volatile solvent such as turpentine, appeals to me far more strongly on technical grounds. With such a medium, flat painting is inevitable, and both in the result and in the working it resembles tempera rather than oil; for which reason I have ventured to call it oil tempera. But it must be remembered that in such a process the pigments are very loosely held—in fact, we find that every endeavour to produce the quality of surface we seek by means of an organic medium leads to practically the same point; distemper, tempera and oil tempera all produce a beautiful

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quality of surface, but one which is little calculated to resist the ravages of our modern polluted atmosphere. As with fresco painting, some protection of the surface, to enable the painting to be cleansed without detriment, is essential.

We may dismiss the question of varnishes in a few words, because although, if properly constructed and applied, they are efficient from the point of view of protecting, they inevitably destroy that quality of surface we have been seeking to produce.

There can be little doubt that the most durable method of painting possible with an organic medium is that employed in coach-painting—executing the painting in oil tempera, or even water-colour, and then sealing from every chance of atmospheric action by successive coats of varnish, each coat being carefully rubbed down before the next is applied, so that ultimately an almost mirror-like surface is produced, hard, elastic, and capable of being washed without injury.

There is no reason why such a process should not be employed in the execution of pictures; in fact, I am inclined to think that the success of Van Eyck in producing permanent pictures —which has been a constant puzzle to later generations— is to be attributed more to some such painstaking method of working than to any secret medium. Such a method is, however, inadmissible for decorative painting; but I would say this in passing, that I would prefer even this, if the only alternative were absolute surrender to the difficulties encountered: acknowledgment of defeat by the absurdity of placing mural decorations under plate-glass.

ENCAUSTIC PRESERVATION.

But fortunately another method of treatment is open to us. We have so far omitted all reference to the process of encaustic painting, the medium of which consists of melted wax. Attempts have been made to revive this method as introduced by the late Greeks and early Romans, mixing the pigments with melted wax and painting with this as a medium. Painting of a very durable character and pleasing quality can be obtained in this way, but the execution of a painting on a large scale by this process would be attended by very great difficulty, for—in this country at any rate—it would be no easy matter to maintain a large wall surface at a sufficiently high temperature to prevent the wax solidifying immediately on being applied to it. But all this difficulty can be obviated by following the hint given us by

METHOD	VEHICLE or Medium	FIXING PROCESS	DURABILITY. Moisture	Acids	Alkali	Dirt
WATER COLOUR	Solution of GUM in Water	Drying	Destroyed	Destroyed	Destroyed	Absorbed
DISTEMPER	Solution of GLUE in Water	Drying	Destroyed	Destroyed	Destroyed	Absorbed
TEMPERA	EMULSION of Oil	Drying + Oxidation	Damaged	Destroyed	Destroyed	Absorbed
OIL	"DRYING" OIL	Oxidation	Slowly Permeated	Slowly Permeated	Destroyed	Readily Cleaned
OIL TEMPERA	"Drying" Oil + Solvent	Evaporation + Oxidation	Freely Permeated	Freely Permeated	Destroyed	Absorbed
SPIRIT "FRESCO"	Wax + Varnish	Evaporation + Oxidation	Slowly Permeated	Slowly Permeated	Destroyed	Partially Absorbed
ENCAUSTIC	1. Solution of WAX 2. MELTED WAX	Evaporation Solidification	Impervious	Impervious	Impervious	Readily Cleaned
OIL VARNISH	Resin + Oil + Solvent	Evaporation + Oxidation	Slowly Permeated	Slowly Permeated	Destroyed	Readily Cleaned
SPIRIT VARNISH	Resin + Solvent	Evaporation	Impervious	Impervious	Impervious	Readily Cleaned
FRESCO	Carbonate of Lime	Carbonation	Unaffected	Rapidly Destroyed	Unaffected	Absorbed
STEREOCHROME	Silicate of Lime	Precipitation	Unaffected	Unaffected	Unaffected	Absorbed
ZINC FRESCO	Oxychloride of Zinc	Chemical Combination	Unaffected	Unaffected	Unaffected	Absorbed
VITREOUS ENAMEL	Fused Glass	Solidification	Unaffected	Unaffected	Unaffected	Readily Cleaned

some of the craftsmen of Pompeii, and combining the advantages of the two methods by executing the painting at leisure in tempera or oil tempera, and subsequently impregnating it with wax, by the method we have already found to solve the same difficulty as regards durability in connection with fresco painting.

And that brings me to the end of our survey of the methods of painting available, and in conclusion I now put together, in the form of a table, the main facts concerning the relative advantages of each process, leaving you to decide between them in the execution of your work, as circumstances may dictate, after having pointed out their respective limitations and difficulties.

May I, however, add a few more words respecting the earnest conviction I have already expressed that artists who desire to produce immortal works under present conditions must of necessity pay some attention to such technical principles? I do not wish to suggest, as some have thought, that I am in favour of the artist attempting to become a chemist as well, but each succeeding year confirms me in the views I ventured to put before this Society on a previous occasion, and which I would here like to repeat:

"The artist cannot be expected to prepare all his materials, as some would have him do; nor do I think he would be much better off if he did. Let us frankly realise that whatever may have been the case in the past—and I doubt myself whether this ever was the case—such a thing is impossible under modern conditions of life.

"There must be two sets of workers—the artists and those who work for them; but these two must work together to the same end if the best results are to be achieved; and to render this possible each must understand and appreciate the aims, the problems and the difficulties of the other. There must, in fact, be co-operation between science and art. And I would say, further, that to my thinking the real function of technical education, as far as concerns such crafts, is to bring about this understanding—to teach the practical craftsman the fundamental principles on which his work is based, which he only learns by long and painful experience in his studio."

I have done what I can to put these views into practice, and I must now take my leave, hoping that I have convinced you of their soundness. If so, I trust that you will study such matters further for yourselves in the daily execution of your work.

USE OF REINFORCED-CONCRETE FOR HORTICULTURAL PURPOSES.

Reinforced-concrete is coming into use for the construction of the frames for forcing by French market-gardeners. The cost of the wood for replacing the sides of these frames, which are so extensively used in French gardening for growing early vegetables, is always a serious item in the expenditure. The damp heat generated by the fermentation of the manure soon causes decay to set in, so that frames made of wood rarely last more than three seasons. The cost of the timber required for renewing a 3-light frame, which usually measures about 12 ft. long by 3 ft. 6 ins. wide, may be estimated at not less than 10*s.*, or at the rate of 3*s.* 4*d.* per annum. On the other hand, panels or sides made of reinforced-concrete are practically indestructible, and their first cost should not exceed 7*s.* to 8*s.*

The front and back panels for a 3-light frame should be 12 ft. to 13 ft. in length and 9 ins. and 11 ins. in height respectively. The two sides, which are 3 ft. 6 ins. long, are 9 ins. high at one end and 11 inches at the other, and can be readily made by an intelligent gardener or handyman. The mould, which consists simply of a smoothly-planed board and two strips of wood 1¾ in. thick for sides, is filled with concrete, well rammed, made of slow-setting Portland cement, in the proportion of one of cement to six of well-washed sharp sand and fine ballast. The panels, which must be reinforced by a trellis-work of ¼ in. round embedded in the concrete, should be 1¾ in. in thickness when finished. Iron rings must be provided at both ends, placed so as to receive iron pins to keep the four panels together and so form the frame.

Water-troughs and tanks, as well as posts for fencing, are now largely being made of reinforced-concrete.

SOYA BEAN PRODUCTION IN MANCHURIA.

A very exhaustive report on the production of the soya bean in Manchuria and its introduction into Europe has lately been published by the Chamber of Commerce at Trieste.

Until quite recently the oil extracted from the soya bean was practically unknown on the markets of Europe. Now it is taking the place of cotton-seed and other vegetable oils for many purposes. This oil, exported to Europe for the first time about three years ago, made a great stir in the trade, and its excellent qualities were soon recognised in Holland, England, and Germany. Since 1909 the demand for this product shows no signs of abating, and Russia and Denmark have since entered the field as customers, whilst Germany and the United States have shown their appreciation of the bean by abolishing the import duty.

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For many years Japan was almost the only foreign customer for this Manchurian product, which from time immemorial has been one of the principal articles of food for the inhabitants of those regions. The chief supply was shipped at Newchanwang, where the trade was entirely in the hands of foreign merchants—chiefly English—established there and their Chinese agents resident up country.

The war between Japan and Russia suddenly changed these conditions, and at the conclusion of peace between the two countries the Japanese became masters of the situation, and managed to divert all the trade to Dalny (now Dairen), the capital of the Kwantung Peninsula. This move was greatly faciliated by the fact that the control of the railways as well as the port of Dalny had passed into their hands.

It was, therefore, an easy matter for them to establish a flourishing trade in Manchuria for the soya bean and its products in exchange for Japanese goods. In this way the Japanese not only succeeded for a time in monopolising the entire export and import trade of the two countries, but even found a market for the product in Europe. This state of things, however, was not of long duration; the example set by the Japanese was soon followed by most of the foreign merchants resident in the country, with such favourable results that the trade is no longer entirely in Japanese hands.

In 1909 the total quantity of soya seed exported from Manchuria amounted to 14,438,049 pikuls* (859,408 English tons), to the value of 32,781,161 Haikwan taels† (£4,097,645), as compared with 4,769,769 pikuls (283,910 tons), to the value of 9,085,379 Haikwan taels (£1,135,672), during the previous year.

The following show the values of the seed exported to various countries during 1909:—

Japan	£749,942
Hong-Kong	521,619
Russia	1,535,920
England	739,050
Australia	51

During the same year the total quantity of bean cake exported from Manchuria amounted to 10,088,359 pikuls (600,498 tons), to the value of 19,247,633 Haikwan taels (£2,408,954), as compared with 7,830,129 pikuls (466,080 tons), to the value of 14,200,839 Haikwan taels (£1,775,105), in 1908. The value of this cake exported in 1909 to some of the principal countries was as follows:—

Japan	£2,456,170
Russia	46,185
Germany	4,262
England	2,109

The exports of the bean from Manchuria in 1910 is estimated at upwards of one million tons, to the value of 25 million dollars (gold), or about 2½ millions sterling.*

In 1909 most of the seed exported to Europe was shipped to England, principally to Hull, where the oil was extracted. The manufactured oil and its residue (bean cake) was sent thence to France, Belgium, Holland, Germany, and Denmark. The following year (1910), however, these countries commenced to import the raw material direct from the East, and to extract the oil themselves.

In 1910 considerable difficulties arose, principally on account of the terrible plague which broke out in Manchuria, and in consequence shippers found it impossible to fulfil their engagements, causing thereby serious losses.

Since then the demand for soya in Europe has steadily increased. Several German firms have established themselves at Dairen and are engaged in shipping this product to Germany, and by means of the steamers of the Hamburg-Amerika line, which call at Dairen and Vladivostock, the transport to Germany is greatly facilitated.

The United States seem about to enter the field as a large buyer, and the admission of the seed and the bean cake duty free will no doubt open the way to establish an immense trade to the Pacific Coast.

The rude methods employed hitherto by the natives for extracting the oil are being replaced by up-to-date processes. An oil factory, fully equipped with modern machinery, was established a few years ago at Dairen by a Japanese firm, with an output of upwards of 12,000 tons of oil in 1910 as compared with 8,000 tons during the previous year.

The yield of oil from the soya bean varies between 13·2 and 22·4 per cent.

In consequence of the great commercial value of the product, experiments are being made in many places to introduce the cultivation of the plant. Good results are reported from Burma, Assam, and in the hilly districts at the foot of the Himalayas, as well as in Ceylon.

The Germans are also endeavouring to introduce the culture of the soya plant in their colonies on the West Coast of Africa.

The great commercial value of this oil cannot be overrated. It is largely used for soap-making; in Germany it is also used in the manufacture of margarine; in France and elsewhere, for preserving articles of food, as sardines, etc., for making sauces, and many other uses.

For the manufacture of paints and varnishes it is also found invaluable, replacing with advantage the more costly linseed and other oils.

As a substitute for india-rubber,† by the treatment of this oil by processes patented by Dr. F. Gosset in Sweden and Dr. A. Sauer in Germany, there may be eventually a large field for the further development of the soya bean industry all over the world.

* Pikul = 133⅓ English pounds avoirdupois.

† Haikwan tael = about 2*s.* 6*d.* English currency.

* The Chinese dollar = about 2*s.* English currency.

† See *Journal*, Vol. LIX. p. 1028.

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THE JAPANESE PAPER INDUSTRY.

Next to cotton-spinning, the production of paper is Japan's greatest industry. Centuries before Western people learned to manufacture paper from rags, the industry was being carried on in China and paper made from actual fibres. From China this art was carried to Europe through Central Asia by the Arabs. It is true that the Egyptians are considered to have been the first paper-makers, but their papyrus was not real paper, but merely the peeled bark of reeds growing on the banks of the Nile. The material for making paper first employed by the Chinese was the so-called paper mulberry bush (*Broussonetia papyrifera*), which is known as "kozu" in Japan. Besides this, the Japanese use the "ganpi," which grows in the mountains of Shikoku, a large island south-west of Kobe, and in the central part of the main island. The Prefectures of Kochi, Ehime, and Kogawa, on Shikoku, and Gifu on the main island, north of the city of Nagoya, lead in paper production. Another plant of no less importance as a material for pulp is the "mitsumata." The value of the annual production of Japanese machine-equipped mills is about £1,600,000, and that of hand-mills reaches £1,900,000. Although native paper has been made from ancient times, it was not until 1872 that the manufacture of European paper was commenced. In that year the Oji paper-mill was established, which uses rice, straw, rags, and waste paper. Soon afterwards factories were established in other parts of the country. After the Saigo rebellion in 1877, a great demand was created for European paper by the rapid adoption of printing in Japan. Whereas native paper is manufactured mainly with hand machines in rural districts affording an abundant supply of pulp, European paper is manufactured in large cities like Tokio, Osaka, and Kobe. Hand-made paper is produced principally by farmers as a secondary occupation, which they can pursue in seasons when there is nothing to be done in the fields. There are no less than 60,000 families engaged in this industry, according to the American representative at Tokio. Japan has been quick in utilising to the utmost its assets in bringing the manufacture of hand-made paper to a high modern standard. In the districts where this paper is made there are experiment bureaus equipped with up-to-date instruments and apparatus for testing and selecting the various kinds of raw material, not only the indigenous plants, but also imported fibres. Co-operation is the secret of the success of the hand-made paper industry in Japan. In every manufacturing district there are guilds which supply the farmers with raw materials and find markets for their product. Experiments have proved that imported wood-fibre may be substituted without detriment in certain kinds of paper for the high-priced native fibres. While Japan exports £406,000 worth of paper annually, it imports £800,000 worth from abroad. The value of the annual consumption of paper in the country amounts to £4,000,000. The domestic production of the better grades of paper is at a comparative disadvantage, owing to the high price of native pulp, the great cost of machinery, and the lack of skill and experience on the part of the operatives. The acquisition from Russia of the island of Sakhalin has furnished a new domestic supply of wood-pulp. This has somewhat lowered the cost of raw materials. A large pulp factory has also recently been established at Shiraoi, on the island of Hokushu.

THE CHILEAN NITRATE INDUSTRY.

Chile has three great productive zones, in some ways quite distinct from each other. In the extreme south, adjacent to the Strait of Magellan, is a newly developing region well suited for sheep and pastoral industries, but showing also mineral possibilities. Its natural product, however, is an abundance of woods, such as pine, where may be found one of the few districts in South America from which building material of this character can be taken. The central part of Chile possesses the famous Central Valley. Here all the products of the temperate zone, and most of those of a sub-tropical climate, grow luxuriantly, and it is by far the most densely populated and highly cultivated part of the Republic. In the north lies the third zone, which appears to be barren, sterile, and worthless, but which in reality, by reason of the nitrate found there, has been the source of much of the wealth of the country. The nitrate fields exported in 1830, the first year of the industry, only about 85,000 quintals (quintal = 220·4 lbs.) of crude material; in 1911 the export amounted to over 53,000,000 quintals, and, according to the International Union of American Republics, there is a visible supply of the nitrate mineral, allowing for increased consumption, for at least the next fifty years.

The nitrate or saltpetre zone embraces an area in the north of Chile of about four hundred and fifty miles from one end to the other. The deposits of the mineral do not lie close to the coast, but are separated from the sea by a district varying from 3,600 to 13,000 feet, in a barren and waterless plain. The climate in this region is delightful, but vegetation is absent, although nitrate forms one of the chief food ingredients of all plant life. Many well-known Chilean ports are on this strip of coast—Pisagua, Junin, Iquique, Antofagasta, Taltal, Caldera—from which the shipment of nitrate is almost the sole business. Saltpetre, or nitrate of soda, is found mixed with other substances. The beds contain four layers of material, the next lowest being that of the nitrate itself. Above this are the "chuca" on the surface, which is nothing more than the accumulation of ages; the "costra" beneath, a harder and older mass, but still somewhat worthless débris; the "caliche," the real nitrate of soda, and finally the stratum of bed-rock called "gova." To obtain the nitrate, a shaft is sunk to the gova, upon which powder is

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placed and exploded. The overlying mass is thrown up and the caliche containing the nitrate is scattered on the ground. This is then collected and taken to the refining works called "oficinas," for preparation into refined and almost pure nitrate of soda, ready for export. In the oficinas, machinery of the very best pattern is used, and the methods of refining are according to the best researches of industrial chemistry. The consumption of nitrate by the principal countries is as follows:—Great Britain takes about 40 per cent., Germany and the United States each about 20 per cent., France about 10 per cent., and the remainder goes elsewhere, even to such far-away places as Egyyt, Japan, the Hawaiian Islands, and Australia. Chile derives a noticeable part of its income from the export tax on nitrate.

IMPORTS OF WINE IN GERMANY.

The quantity of foreign red wine imported by Germany, for mixing with that of native growth (*vins de coupage*), appears to have fallen off of late years. According to the report of an Italian expert, resident in Berlin, this decrease has been particularly noticeable during the first six months of last year, when only 28,200 hectolitres (620,400 gallons) of wine for that purpose were imported, as compared with 46,286 hectolitres (1,018,292 gallons) during the corresponding period in 1910.

This falling-off is attributed to the shortage in production of this class of wine in Germany, and its high price both at home and abroad. In consequence of this, many of the principal wine makers and merchants in Germany now find it more profitable to import table wines in preference to those for mixing (*coupage*) as was formerly the practice.

The following shows the quantities of this latter class of wine which were imported during 1909 and 1910, and the countries in which they were produced:—

	1909. Hectolitres.	1910. Hectolitres.
Spain	47,830	39,628
Italy	7,804	11,650
Greece	4,058	9,088
France and Algeria	16,330	3,934
Portugal	..	2,226
Austria-Hungary	337	516
Turkey	736	505
Total	77,095	67,547
Gallons	1,696,090	1,486,034

THE SPANISH CORK INDUSTRY.

The cork tree is a species of oak whose outer bark, which is the commercial cork or "corkwood," is first stripped when the tree has a circumference of about sixteen inches, and thereafter regularly every nine or ten years throughout the life of the tree. The best bark, commercially speaking, is produced when the cork tree is fifty to one hundred years old. Stripping the bark, which is usually done during the summer months, is necessarily a rather delicate operation, as great care must be taken not to wound the tree. In many parts of Spain cutting is done by a hatchet, which perforates the bark in complete circles at the base of the tree, and at the lowest fork of the branches. This cylinder-like coat, by a downward slash, is then generally loosened from the inner bark of the tree, and is removed by the aid of a wooden wedge. The same treatment is accorded such larger branches as will yield bark at least half an inch in thickness. The bark taken from the tree trunk sometimes measures more than two inches in thickness, and the total yield of the tree occasionally reaches 500 pounds, though this yield varies enormously from fifty pounds upward, in accordance with the age and size of the tree. After having been stripped, the bark is generally left for a few days to dry. It is then weighed and taken to the boiling station. The simple boiling process makes the bark soft and flexible, and, quite as important, renders easy the scraping off of the woody weather-hardened outer coating which is commercially useless. Occasionally the boiling station is located near the cork forest; in other instances at the shipping port, where the cork factories are situated. At these factories the bark is sorted very carefully, according to quality and thickness, and is then—if for sale as raw corkwood—baled for shipment. The United States Consul at Seville says that by far the greater quantity of the cork yield of Andalusia is exported in the unworked state to England, Germany, Austria, and Belgium, as well as to the United States. An American firm has a branch house at Seville, from which it ships to its home factory a very large quantity of the "corkwood" to be manufactured into articles of commerce. Other local factories produce for domestic and export purposes a relatively small number of manufactured articles, although with the installation of machinery the output is gradually widening in scope and increasing in quantity. In the manufacture of these articles there is a very great amount of unavoidable waste, which is largely exported in the form of cork shavings for use in making linoleum and other by-products of cork. Of all the uses to which corkwood is now put the manufacture of corks themselves still remains pre-eminent. Formerly corks were made almost entirely by manual labour; the workers cut the bark into small squares, from which they whittled out each cork by hand. At the present time this method is still employed in the very small and unimportant "home" factories, where the family

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constitutes the working force, but the larger local establishments use very satisfactory machinery for the production of corks and discs. One local factory, to supply the export demand for the typical "hand-made cork" (an almost square cork with rounded corners), has invented and installed a simple-moving blade machine, worked by hand. This combines speed with accuracy, and turns out the desired "hand-made" type of cork. The manufacture of a cork is an interesting process when watched from the beginning. Before use at the factory the cork bark in loose bales is boiled for half an hour to render it pliant; upon drying it is sorted into at least ten grades of differing quality and thickness. This sorting is most important, if waste is to be reduced to a minimum, for corks are cut from the bark transversely, and are hence limited in their diameter (rather than in their length, as might at first be supposed) by the thickness of the bark. After sorting, the sheets of bark are cut into strips and squares, according to the length of the cork desired. Next the cork itself is carved out of the small square block, polished by a sand-papering machine, washed, sorted, and disinfected. The corks are counted by an ingenious French machine, and shipped in sacks of strong burlap, containing generally from 100 to 150 pounds. Cork discs, for use in lining metal stoppers, are fast becoming an important article of trade in the cork industry. In their manufacture simple machinery is employed, worked in some factories by an electric motor. Among the other articles in the manufacture of which cork is increasingly used are life preservers, cigarette tips, instrument handles, polishing wheels, carburetter floats for automobiles, etc. These articles, however, are not made to any great extent in Andalusia. For the manufacture of such cork articles as are produced there, the local factories are, as a rule, fairly well equipped with machinery, when the very low cost of manual labour is considered. The enormous waste of cork which is inevitable in the manufacture of cork articles—approximately from one-half to two-thirds of the total material—is not in reality a loss. Naturally, the best of the cork bark is utilised in cork products, and the refuse and shavings are exported to England, Germany, and the United States to be used in such valuable by-products as linoleums, cork-tiling, and other composition articles.

TRADE BETWEEN CORSICA AND THE RIVIERA.

A considerable trade has sprung up of late years between Corsica and the Riviera in agricultural and other produce, which is shipped chiefly to the port of Nice. Amongst the principal articles imported from the island are early fruit and vegetables (*primeurs*), live-stock, fresh meat, game, fish, cheese, olive oil, wine, charcoal, and timber for building.

The trade in early vegetables and fruit, which was commenced some fifteen years ago, has, thanks to the "Comité des Interêts Corses de Nice," and other similar institutions in the island, grown in importance every year. This produce is shipped chiefly at Bastia.

During the three months ending March 31st of the present year, these shipments consisted chiefly of 136 tons artichokes; Tangerine oranges, 22 tons; green peas (the earliest in the market), 20 tons; sweet chestnuts, 17 tons; onions, 45 tons; and a small quantity of apples, nuts, etc.

The trade in live-stock has been less active during the last quarter than formerly, in consequence of the high prices prevailing in the island; the numbers being 16 horses, 32 goats, and 740 pigs. The fresh meat, of which 17 tons were imported, was chiefly lamb or kid. The quantity of fresh fish—45 tons, and two tons of lobsters—was less than usual. This is due to the close season during January and February, when fishing operations were suspended.

Enormous quantities of small birds, mostly thrushes, are exported to Marseilles, Paris, and other towns in France. They are much esteemed by epicures, and are sold in Paris as "Swiss thrushes."

The cheese made in Corsica is of excellent quality. The various cheese factories established on the island during the last three years have an output of upwards of $1\frac{1}{2}$ million kilogs (1,500 tons) annually, which is supplied to the cheese makers of Roquefort, to whom it is sent to be finished and seasoned in their celebrated cellars. A special kind of cheese, made also from ewe's milk, called "Cyznosfort," is likewise a product of the island. It is said to rival the better known Roquefort. Only three tons of cheese were imported to Nice during the quarter.

The wines made in Corsica are of excellent quality, and certain growths, notably the *Cervione*, *Sartène*, *Tallone*, *Corte*, and *Cap-Corse*, are bought up by the large wine firms in Nice. The wine crop last year was an average one.

The olive crop for the last four or five years has been very good. Last year's crop in the district of Balagne, which was exceptionally good, realised upwards of six millions of francs.

The quantity of oil imported to Nice during the quarter was 365 tons; this quantity, no doubt, would have been far larger were more care taken in the process of extraction by manufacturers in Corsica. Many proprietors of oil-mills at Nice and in the department of the Alpes-Maritimes now prefer to import the raw olives, from which they extract, by more up-to-date methods, a superior quality of oil to that made in Corsica. Sixty-nine tons of raw olives were landed at Nice during the three months ending March 31st last. Charcoal is imported to Nice by the steamers of the Fraissinct Company in sacks containing 80 kilogs (176 lbs.), and in bulk by sailing craft.

The quantity of charcoal landed at Nice was 872 tons during the quarter. About 500 tons of timber for building, and 48 tons of cork, chiefly

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cuttings and waste, to be used for manufacturing linoleum, etc., were also brought during the same period.

The value of the exports from Nice to Corsica is very trifling, as the principal manufactured goods are sent direct from Marseilles.

The number of passengers embarked for Corsica was 1,830 during the first three months of the present year. An expenditure of 1,350,000 francs (£54,000) for harbour improvements at Nice has just been sanctioned by the French Government, who will contribute to the extent of 675,000 francs (£27,000), whilst of the remainder, 450,000 francs (£18,000), and 225,000 francs (£9,000), will be provided by the town of Nice and the Chamber of Commerce respectively.

These improvements will consist chiefly in the construction of about 300 metres (nearly 1,000 feet) run of quays and a graving dock.

The port is frequented by vessels up to 1,000 to 1,500 tons. There is a depth of water of 7½ metres (24 feet 9 inches) in the outer, and of 6 metres (19 feet 8 inches) in the inner harbour.

ENGINEERING NOTES.

Internal-combustion Marine Engines.—The adoption of internal-combustion engines for ships marks what may be as complete a revolution in the conduct of maritime transport as, through identical means, has taken place in land road transport. A few months ago the engineering and other papers were full of the accounts of the trial trip of the "Selandia," with internal-combustion engines for her motive power. Though there are plenty of smaller vessels so equipped, especially in the case of the North Sea fishing-boats, the "Selandia" is the first ocean-going vessel of this character. Trial trips and shop experiments are, of course, valuable in their way, but the experience of an actual voyage is infinitely more so. The "Selandia" has now returned from Bangkok, after a run of 21,840 miles, with an average amount of rough weather. She called at sixteen ports, involving much manœuvring in entering and leaving them. The "Selandia" is 370 feet long, 53 feet wide, has a dead-weight capacity of 7,000 tons, and a speed of 12 knots. There are two Diesel main engines, each of 1,250 horse-power, driving twin-screws, and two auxiliary engines, each of 250 horse-power. Each main engine has eight cylinders on the Otto cycle, and runs 140 revolutions per minute. It was the longest voyage yet accomplished by a motor-ship, and everything seems to have turned out perfectly satisfactory. Further experience, no doubt, is necessary, but no inherent defects have been found in the principle of 4-cycle motor propulsion. It is proved, moreover, that 9,300 tons of cargo have been carried 21,840 miles by the consumption of nine tons of fuel per twenty-four hours, and with an engine-room crew of ten men and three boys.

There are also some other large vessels which have been launched recently to be worked on the same principle, such as Messrs. Furness, Withy & Co.'s vessel "Eavestone," built by Sir Raylton Dixon & Co., which has undergone satisfactory trials; the "Innesburg," of the Coasting Motor Shipping Co., and the "Fiona," belonging to the same owners as the "Selandia," namely, the East Asiatic Co. This company also launched some time ago the "Jutlandia," which is a sister-ship to the "Selandia," also motor-driven.

An interesting article in the *Engineer*, recently published, shows that if a vessel the size of the "Mauretania" were fitted with internal-combustion engines, and the ship built with a double skin, with an average space of one foot between the skins, making for strength and safety, the space thus provided would hold sufficient residual oil for a voyage across the Atlantic, and partly back again. The figures are given, and the article is worth attention as emanating from a trustworthy authority.

Non-ferrous Metals.—It has been rather the fashion of late in engineering circles to describe systems and things by what they are not, such, for instance, as wireless telegraphy and the trackless trolley, and now we have an important exhibition, which was held at the Agricultural Hall about a month ago, called by the name of "The Non-Ferrous Metals Exhibition." There were two hundred exhibits of a very interesting nature, such as those by the Delta Metal Company, Thermit Welding Anti-Friction Metals, Muntz Metal, and a good show by the British Aluminium Co.

The Engineering Trades.—With regard to the iron trades of Birmingham and Wolverhampton, the vexed question of a bonus for puddlers has at last been settled, and, owing to increased wages, manufactured iron prices have been advanced 3*s.* 6*d.* to 5*s.* per ton. Nearly all items in the steel and iron trade have advanced considerably owing to largely increased demand. In steel bridges, roofs, railway waggons, boilers, tanks and joists, rolled steel, steel tube strip, etc., there has been a pressure in orders which it has been difficult to meet, and in Lancashire much of the same condition of things exists, as well as in the North of England and Scotland, and in many instances orders have been received which will keep the firms busy right up to the end of the year. Vickers & Co. have launched a floating dock for Canada in three sections, and there has been a busy time in regard to ship plates. The pig-iron trade has advanced also rapidly, and 1912 promises to be a record year for several departments of engineering and the allied trades. Exceptions, however, must be made in the case of textile machinery and steam engines, the latter suffering, both in this country and in Germany, in the competition by steam turbine and central electric station work. The locomotive trade can only be said to be in an average condition.

The export of railway material of all kinds for the six months ending June last, the figures of

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which have just been published, show an increase from the corresponding period of 1911 of £284,142; he total amount is £4,687,651, the principal increases being in rails, waggons and fittings, while wheels and axles, tyres and locomotives show a decrease. British South Africa and Australia are principally responsible for the increase, while as regards rails in particular, India, Australia, and New Zealand have led the way.

The electrical industries, which have been in a state of considerable depression for the last two or three years, owing, it is said, to foreign competition, have now turned the corner, and at a good many of the general meetings of the electrical supply firms which have been recently held, there has been mention of marked instances of substantial recovery, which most of the chairmen believe will be maintained. The electrical industries have such a considerable share in supplying engineering undertakings, that they are properly included in a review of this kind.

A circular has just been issued from the Midland producers notifying an advance in marked iron bars of 10*s*. a ton, making the basis £9 10*s*., with the usual 12*s*. 6*d*. extra for the Earl of Dudley's brand. The last advance was in April, due to the coal strike, and was from £8 10*s*. to £9.

OBITUARY.

David Harris, F.R.S.E.—Intimation has been received of the death of Mr. David Harris, at his residence, Lyncombe Mount, Bath, on June 17th, at the age of seventy. Born at Dunster, Somerset, he was at the age of twelve apprenticed to a provision merchant at Boston Spa, Lincolnshire. A few years later he entered the service of Messrs. Reynolds, wholesale provision merchants of London. When about twenty-four years of age, Mr. Harris was appointed as manager in Edinburgh of an insurance company. Here he made the acquaintance of the late Mr. A. B. Fleming, founder of the oil and printing-ink business, Caroline Park, Granton, N.B., and London, and, joining the firm as a partner in 1872, he continued as commercial managing director for over twenty-five years. Besides holding this post, Mr. Harris was chairman for many years of Messrs. Bertrams, Limited, the well-known paper-makers' engineers, of Edinburgh and London, and was chiefly instrumental in converting the firm of G. & W. Bertram (founded in 1821) into a limited liability company in 1888. Mr. Harris was also chairman for a long period of the great North of Scotland Granite Company, Ltd., of Peterhead. In recent years he has been chairman of some successful rubber companies of Edinburgh and London.

In addition to filling these posts, Mr. Harris was for many years a director of the Edinburgh Chamber of Commerce, a director of the Edinburgh Royal Infirmary, a Fellow of the Royal Society of Edinburgh, and a Fellow of the Statistical Society. He was also one of the founders of the Edinburgh Industrial Brigade Home for Lads, one of the directors of the Edinburgh Night Refuge—an institution where vagrants and the destitute are received and assisted—a director of the Training Home for Girls, in Edinburgh, a director of the "Mars" Training Ship for Boys, stationed in the Tay, between Broughton Ferry and Dundee; one of the founders of the Discharged Prisoners' Aid Society, Edinburgh, and of the Edinburgh Grove Laundry, which is a rescue institution for discharged women prisoners. Mr. Harris joined the Royal Society of Arts in 1884.

NOTES ON BOOKS.

War and the Private Citizen. By A. Pearce Higgins, M.A., LL.D. London: P. S. King & Son. 5*s*. net.

This volume forms No. 27 of the admirable series of monographs by writers connected with the London School of Economics and Political Science, which is being edited by the Director of the School, the Hon. W. Pember Reeves; and in the opinion of the Right Hon. Arthur Cohen, K.C., who contributes an introductory note, it is "by far the most instructive and valuable work that has been written on the Hague Conferences and the London Naval Conference of 1909." As Dr. Pearce Higgins remarks, the ordinary Englishman knows nothing of what war means from personal experience, and his object in these lectures is "in an atmosphere of academic calm . . . to draw the outline in no uncertain manner"; he wishes, in a word, to do for us legally what "The Englishman's Home" did for us in dramatic fashion.

One of the most striking sections in the book deals with the suddenness with which war may break out. The Russo-Japanese War, for instance, commenced without any formal declaration; indeed, so sudden was the action of Japan, that Russia complained to the Powers that the enemy has committed "a gross act of treachery." Dr. Pearce Higgins also quotes from a speech by Lord Granville, on taking office as Foreign Secretary on July 11th, 1870, in which he states that the Under-Secretary at the Foreign Office had informed him that never during his long experience had he known so great a lull in foreign affairs. Eight days later, on July 19th, the Franco-Prussian War broke out. The outbreak of the Turco-Italian War was even more sudden. "On September 25th 1911, the world first heard of serious complaints by Italy against Turkey. On September 28th an Italian ultimatum was presented, and next day Turkey replied in a pacific sense, and that day, at 10 p.m., Italy declared war and commenced hostilities . . . If a State is determined on war," continues Dr. Pearce Higgins, "it will seize the

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moment it thinks most advantageous for making its formal declaration."

After dealing with the laws of war in relation to the private citizen, the author proceeds to discuss the questions of hospital ships and the carriage of passengers and crews of destroyed prizes; newspaper correspondents in naval warfare; the conversion of merchant ships into warships; and the opening by belligerents to neutrals of closed trade. Dr. Pearce Higgins is well known as a lecturer on public international law both in London and in Cambridge, and his criticisms of the work achieved at the Hague Conferences are as valuable as they are impartial.

GENERAL NOTES.

Social Research Prize, 1912-13.—The Governors of the London School of Economics and Political Science (University of London) offer a prize of £100 for the best essay or monograph submitted by July 31st, 1913, on one of the following subjects:—(1) An analysis, quantitative and qualitative, of the annual consumption of wealth in the United Kingdom, showing in what the total product of commodities and services actually consists, and how and by whom it is "consumed," and as far as concerns any parts of it, with what unsatisfactory or positively deleterious results. (2) The actual working and ascertained results of the Old Age Pensions Act, with suggestions for its improvement. (3) A survey of any village or small town in Great Britain accompanied by an estimate of its characteristic advantages and its limitations, with suggestions for improvements (*a*) from within; (*b*) from without. (4) A New Factory Bill, which should, without adopting any new principle, by appropriate technical clauses in Parliamentary form, extend and make applicable to every section of employed persons in the United Kingdom all the various protective provisions now applicable only to particular sections in the existing Factory, Workshops, Truck, Shop Hours, Railway and Mines Regulation, Trade Boards, Merchant Shipping, and similar Acts; with a view to securing by law to every worker such a national minimum of education, sanitation and safety, leisure and rest, and subsistence as is already prescribed by law for some workers. (5) Whether, and if so in what manner and to what extent, the best economic use of land in Great Britain, urban or rural, is prevented by (*a*) considerations of sport or pleasure; (*b*) restrictive covenants in leases or other conditions of tenancy; (*c*) life interests, trusts and other forms of limited ownership; and (*d*) the system of assessment and rating, and other methods of taxation. (6) Whether, and if so under what circumstances and to what extent, the agricultural industry as it is or as it might be carried on in Great Britain could afford higher wages to those engaged in it. If suitable monographs or essays are submitted, five, or possibly more, additional prizes will be given, value £5 each. The competition will be open to all, without restriction of age, sex, nationality, residence, educational qualifications or connection with any university or other institution. All inquiries should be addressed to the Secretary of the London School of Economics and Political Science, Clare Market, Kingsway, London.

The London School of Tropical Medicine.—At the request of the Right Hon. L. Harcourt, Secretary of State for the Colonies, a committee has been formed to raise funds for the extension and development of the London School of Tropical Medicine. In order to provide an endowment fund, to make necessary additions to the laboratories and buildings for the accommodation of the growing number of students, to provide for the active prosecution of research and to establish a small nursing home for civilians who cannot afford to procure for themselves the special medical and surgical treatment and nursing required in these very special branches of disease, the committee is appealing for the sum of £100,000. The preliminary list of contributions already amounts to upwards of £30,000. This school was founded by the Seamen's Hospital Society in 1899 under the auspices of the then Secretary of State for the Colonies, Mr. J. Chamberlain, who regarded it as the discharge of a duty owed by this country to its representatives in our tropical and semi-tropical dependencies, and as a necessary step towards the agricultural and commercial development of those territories. For the same reasons the school has received the warm support of successive Secretaries of State both for the Colonies and for India. The branch of the Seamen's Hospital at the Royal Victoria and Albert Docks was selected as the site of the school, because it is situated in the most populous shipping centre of London, and close to the wharves where vessels arrive from every part of the tropical world. On these vessels are found the victims of many of the tropical diseases, and the students who are being trained have under their observation and treatment many of the conditions and ailments with which they will have to deal in the tropics.

The U.S.A. Harvest.—The harvest in the United States this year promises to be extremely good. "If present calculations are realised," writes Dr. Henry Clews, "we shall garner a 700,000,000 bushel wheat crop, a 2,900,000,000 bushel corn crop, and a 1,200,000,000 bushel oats crop. The yield of potatoes and hay is also likely to be considerably ahead of last year. The total value of these five crops is estimated at $3,600,000,000, or about $200,000,000 ahead of last year. In all probability the aggregate of all agricultural wealth produced this year will be about $9,000,000,000, as against $8,500,000,000, the figures of the Department of Agriculture last year. What this annual production of new wealth means to this country

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may be estimated when it is remembered that the capital stock of all the railroads in the United States is placed at $8,470,000,000. An increase of $500,000,000 in agricultural products in a single year cannot but be a powerful stimulus to business."

THE CENSUS RETURNS.—The second volume of the detailed abstracts of the Census returns, just published as a Blue Book (Cd. 6259), contains the population figures of registration counties, districts, and sub-districts, and also the aggregate number of marriages, births, and deaths registered in each registration county and district during the years 1901–11. The number of families (denoted by the number of schedules returned) is found to be 7,970,660, and the number of members 34,776,402, an average of 4·4 for each family. In all counties the births registered outnumbered the deaths, so that had there been no migration the population in every county would have been greater in 1911 than in 1901. But, as a matter of fact, of the fifty-five registration counties there were seven—London, Cumberland, Westmoreland, Cardigan, Radnor, Montgomery, and Merioneth—in which the population decreased. These seven counties had not only lost all their natural increment, but something over and above, owing to losses by migration. There were thirty-one other registration counties in which the actual increase was less than the natural increase, while in the remaining seventeen counties the actual growth, as shown by enumeration, was in excess of the natural growth, as shown by excess of births over deaths. Of the seventeen counties which absorbed population from without, some of the largest gains from migration were in the counties surrounding London—namely, Middlesex (22·7 per cent.), Surrey (15·5 per cent.), Hertford (8·9 per cent.), and Essex (8·5 per cent.); while two counties, in which mining is the leading industry, also showed considerable gains—namely, Monmouth (10·9 per cent.) and Glamorgan (10·6 per cent.). The aggregate number of marriages, births, and deaths were respectively 2,641,170, 9,290,058, and 5,245,411, showing an increase of population of 3,542,649, and an excess of births over deaths of 4,044,647.

INTERNATIONAL EXHIBITION OF ARCHITECTURE AT LEIPZIG, 1913.—An international exhibition of architecture and building construction will be held next year at Leipzig under the patronage of the King of Saxony. Special facilities will be granted to foreign exhibitors by the custom house authorities and on the railways in Saxony.

PRODUCTION OF RICE IN JAVA, 1910.—The production of rice in the island of Java, according to an Italian Consular report from Batavia, amounted in 1910 to 82,866,916 pikuls,* or 4,932,554 English tons.

* The pikul equals about 133⅓ English lbs.

THE BRICK AND TILE-MAKING INDUSTRY IN DENMARK.—Brick-making in a country like Denmark, destitute of stone, where the buildings are chiefly constructed of brick, of necessity must be an important industry. There are upwards of 200 works throughout the kingdom where bricks and tiles of every description are made. Denmark, notwithstanding, imports a considerable quantity of these materials annually from her neighbours, chiefly the south of Sweden and from some of the outlying islands. The cost of carriage by small sailing craft is very low. There is no import duty on bricks and similar materials in Denmark. A considerable quantity of bricks and tiles, both ordinary and glazed, are also imported from Germany. Fire-bricks and fire-proof tiles for lining stoves, furnaces, etc., are brought from these countries as well as from England. It is possible that the brick-makers of Kent might find a good market for their products in Denmark, especially for the superior qualities of bricks and tiles.

MANUFACTURE OF ORIENTAL CARPETS AT MISRATA.—Misrata, just occupied by the Italian troops, is one of the most important, if not the only manufacturing town in the provinces of Tripoli and Cyrenaica. Situated near the coast, about 120 miles east of the town of Tripoli, Misrata, besides various other industries, has been famous from time immemorial for the weaving of the richly coloured Oriental carpets and rugs known throughout the East by its name. The characteristic designs and hues of these carpets are now successfully copied by the Germans, who have for many years past inundated the bazaars of most of the towns on the North African coast with their clever imitations, which are difficult to distinguish from the genuine article. The town, which is situated in a fertile oasis surrounded by trees and gardens, is inhabited by many wealthy residents chiefly engaged in trade and manufacturing industries; and they no doubt will soon learn to appreciate the new *régime*.

THE TRADE OF COSTA RICA.—The Italian Consul at San José, in his report on the trade of the Republic of Costa Rica, states that the total value of the exports from that country in 1911 amounted in value to 18,009,385 colones (£1,721,740), and the imports during the same period to 16,044,444 colones (£1,533,876). The chief articles of export, which are principally to the United States and England, were bananas, coffee, cacao, hides, sugar, sugar-cane, mahogany, mother-of-pearl, gold and silver in bars. The imports, which are chiefly from the United States and Europe, were dry goods, hardware, provisions, railway material, and general merchandise. The imports to Italy at the present time are comparatively insignificant—on the other hand the exports from that country to Costa Rica have a certain importance; the principal articles were felt hats, umbrellas and parasols, marble, wine, vermouth, and a variety of other goods.

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Journal of the Royal Society of Arts.

No. 3,118. VOL. LX.

FRIDAY, AUGUST 23, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C

NOTICE.

CANTOR LECTURES ON "THE MEAT INDUSTRY."

The Cantor Lectures on "The Meat Industry," by Mr. Loudon M. Douglas, F.R.S.E., have been reprinted from the *Journal*, and the pamphlets (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor Lectures which have been published separately, and are still on sale, can also be obtained on application to the Secretary.

THE RAJPUTS IN THE HISTORY OF HINDUSTAN.

By Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

Part I.

"His hidden meaning dwells in our endeavours,
Our valours are our best gods."
John Fletcher, *Bonduca*.

We stand at the present moment at the parting of the way followed by us for the past 150 years in India; and if we would take true divination of the goal, on the right hand or the left, whereto our searching arrows are winged, nothing could be more helpful to us than a close study of the character and the history of those who before us have held paramount power over the country,—the warrior caste of Rajputs, the priestly caste of Brahmans, and the fierce Islamites [Arabs, Afghans, and Mo(n)gols] who held both in more or less complete subjugation throughout the 1,046 weird, penitentiary years preceding the revindication of Aryan supremacy in India under the mighty seven-fold shield of the "British Raj." This paper treats only of the Rajputs; and on the basis of Miss Gabrielle Festing's "From the Land of the Princes," and Colonel James Tod's "Annals of Rajasthan." Miss Festing's book does for the stirring national traditions, and dynastic chronicles of Rajasthan, "the land of Kings," what Charles Kingsley and the Rev. Alfred J. Church did for the tales, from Homer, Hesiod, and Herodotus, of the gods and heroes of ancient Greece. She has epitomised the bardic legends, or *rashas*, as they are termed by the Rajputs, or "Sons of Kings," which were first systematically gathered together for English readers by James Tod; who, going out to Calcutta at the impressionable age of seventeen, after serving in the Intelligence Department of the Army during the operations undertaken by Lord Hastings in 1817 against the Pindaris, was appointed in 1818 Political Resident at Udaipur, the capital, in succession to Chitor, "the Painted," of Mewar, "the Mid-ward" * of Rajasthan.

The Four Castes of Hindus.

The Hindus hold the *Maharana*, or "Great-King" of Udaipur, as the reputed descendant, in the direct line of primogeniture, of the eponymous hero of the *Ramayana*, and, of divine right, the absolute head of the Solar Rajputs, to be sacrosanct above all other Rajputs; these Solar Rajputs, with the Lunar Rajputs, or descendants of the kin Kaurava and Pandava Princes, the antagonistic heroes of the *Mahabharata*, constituting the *Kshatriya* [*cf.* "Satrap"] or "Sovereign" caste, the second,

* The Hindus designate the whole country between the valley of the Indus and the valley of the Jamna and Ganges, and between the Himalaya and the Vindhya mountains, *Madhya-desa*, *i.e.*, "the Middle Land"; the Mahrattas apply the term to the country between the Konkans and Khandesh; while all Hindus refer to the cradle of their race in Central Asia as *Madhya-bhumi*, *i.e.*, "the Middle-Earth." The Sikhs similarly name the land round about Lahor, as the original home of their sect, *Manja*, a local form of the Sanskrit *madhya;* this word, over all India, also meaning the land between any two villages, "the Hub of the Universe" for each village. "Media" is probably the same word.

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after the *Brahman* or "Priestly" caste, of the three "Twice-born" sections [the third being the *Vaishya* or "Settled" caste of traders], into which the primitive Aryan invaders of India, under the operation of the natural and economic influences, systematised by the "Code of Manu," and similar law books of the Hindus, became separated; the fourth Brahmanical caste of *Sudras*, or "Shattered-serfs," representing the subjugated aborigines,* or, at least, the pre-Aryan people of the country.

RAJPUTANA.

Seventy miles westward from Udaipur, at the angle formed by the northward emergence of the Aravali Hills from the Vindhya [" Dividing" between Hindustan and the Dakkan] Mountains, towers, to the height of 5,650 feet above the sea, the abrupt dome of Mount Abu [Arbuda], famous for its Jaina temples—like the wonderful Jaina temples, rising terrace upon terrace, up the slopes of the Satrunjaya Hill in Kathiawar—all of white marble, sculptured outside and inside, both pillars and roofs, with the finish and refinement of carved ivory or ebony, an ecstasy of the art of mystical architecture: "a Satanic mockery"—as the revered Dr. John Wilson, with pardonable professional prejudice, once pronounced them—"of that heavenly Jerusalem whereinto shall nowise enter any thing that defileth." This cone, the *guru-sikhar*, "Saint's Sanctuary" [literally "Pinacle"] of the Jainas, is the culminating point of the Aravalis [literally "Row of Peaks," "Stockade"]; the "strong Refuge" of the Rajputs when overwhelmed in the flood of the successive Mahometan invasions of India from the eighth to the eighteenth centuries A.D.; and again when, driven by outrageous oppressions, senselessly prosecuted through successive centuries, they from time to time revolted against the Afghans and the Great Mo(n)gols. From Mount Abu the Aravali Hills range boldly north-eastward, straight as an arrow, through the midst of Rajputana, "the Land of Princes" [called also Rajwara,* "the Ward—the Dwelling-Place of Princes"] for about 200 miles; whereafter they begin to decline from their pre-eminence, and become more and more disconnected; cropping up again before they finally disappear under the alluvium of the plain of the Jamna, in the historic "Ridge" at Delhi, 360 miles north-east of Udaipur. As now restricted to the States lying between the Indus and the Jamna, a little less than one-half of Rajasthan—that is Marwar [Jodhpur], Jeisalmir, Bikanir, and Sirohi—lies to the westward of the Aravalis, and is watered only in Marwar and Sirohi, by the "Salt" Luni, as it flows southward to the Rann, or salt-"Waste" of Cutch; and a little less than one half—that is Mewar [Udaipur], Amber [Jaipur], Kotah with Bundi [Haraoti], etc., watered by the many affluents of the Chambal, as it flows north-eastward to the Jamna—lies to the eastward of these hills. The British province of Ajmir, "Aja's Hill," with Mairwara, "the Highland-ward" [compare Mount Meru], extends over the middle third of their crest; the City of Ajmir, dominated by Taragar [" Star-garth"] 2,855 feet above the level of the sea, making the point wherefrom the Aravali Hills begin to decline toward Delhi.

Situated on the verge of the Tropic of Cancer, Rajputana falls within the Northern Solstitial Zone; the desert tracts of Persia, Syria, Arabia, the Sahara of Northern Africa, and the *Tierra caliente* of Mexico, marking other, so to say, broken links of the Earth's close clinging girdle ["shingles"] of fire and famine. Where not an absolute desert, as in the Thul, *i.e.*, "The Deadly-region," between the Luni and the Indus, and parts of Marwar, *i.e.*, the "Deathward," or "Grave-yard," Rajputana is still an arid, and, for the most part, sterile land; but relieved within the morning and afternoon shadows of the Aravalis,—intermittently along the banks of the brackish Luni, and continuously, and in greater breadth, in the courses of the Chambal and its contributories,—by green tracts of wild woodlands and herbage, and of cultivated fields and orchards, and pleasing gardens; and further diversified by the mediæval walled towns, uprising on the rock-crested ridges

* The word used in the *Mahabharata* and the *Rig-Veda* for the people the Vedic Aryas found in India is *daysu*, the equivalent of the Hindustani *deshi*, *i.e.*, "of the country"; but the Vedic and Epic term *daysu* includes brown Hamites [Dravidas], and yellow Turanians [aboriginal Bangalas], as well as absolute autochthons, probably, of the Negroid [blackish] colour of the Andamanese. The Sanskrit word for "caste" is *varna*, literally "colour"; and caste, in its origin, was the colour-line between white and brown, and white and yellow, and white and black, men in India; and between shades of these mixed colours, the Sanskrit word for the innumerable Brahmanical sub-castes of the present day being *varna-sankhara*, and meaning, simply, "colour-intermixture," "colour-confusion." In the phrasing of ethnologists, India west of the confluence of the Ganges and Jamna, and southward into Gujarat and Kathiawar is "India Alba"; east of this confluence and on into Burma, "India Flava"; and Southern India, the Carnatic, "India Nigra."

* The familiar Rajput denomination of Rajputana is Rajvara; *vara* here, not being used in the sense of "ward" exactly, nor of "heaven" [*cf.* "pan-orama"] or "property" [*cf.* Trolsworthy in Devonshire], but rather of "warren," with the meaning of "our own endeared home-land."

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of sand rippled over the wide extended plains, as if so many islands, or so many huge turreted ironclads riding grimly at anchor, moored with two anchors, on a swelling sea. Vast herds of camels and horned cattle, and innumerable flocks of sheep, ever in search of new pastures, freely wander everywhere; and behind all is the more or less distant background of the everlasting Aravali Hills with their shimmering peaks of white and rose-coloured quartz. The varied prospect, with its contrasts so harshly accented by the dry glitter of a sub-tropical midday, as seen embalmed and harmonised in the softer amber light of morning, or suffused with the refreshing rosy flush of evening, is at once transfigured to a fairy land. In a moment, one's own soul is brought face to face with, as it were, the very soul of the soil, and its foster-children, and their history, and their autochthonous gods, —the gods of the land; and the impression thus suddenly created by the transient scene, abides for ever with the spell-bound beholder.

James Tod.

At Udaipur young James Tod was fascinated by everything around and about him; by the spiritualising picturesqueness of the landscapes; the gay colourings of the Palatine Cities—the white and green of their painted houses; the rose madders, and other reds, and lemon and saffron yellows, and cobalt and indigo blues of the nodding turbans, and swaying girdles, and twinkling shoes, of the white-robed people in the spacious streets; and the vermilion, and Chinese yellow, and indigo-blue flags of all the gods, fluttering among the green trees in every air of heaven that breathes about the frequent temple spires; and by the lofty Palaces of the Rajput Princes, and the stately splendour of their military Courts, and their own manly, gallant bearing and fine "civility of manners, arts, arms, and long renown." Beyond all else he was moved by their old feudal fortresses, and the shrines and temples of their gods, instinctively adapted as these are to the sentiment of the country and its inhabitants, and their chivalresque history. Seen day by day in sunshine and shadow, and month after month in all the glamour of the full moons of India, and sketched and painted over and over again by himself, it was the aerial architecture of the visionary summits and peaks of the Aravali Hills that, to the subjective sensibility of James Tod, touched Rajputana with supreme enchantment. With an industry, assiduity, and perseverance, only enthusiasm like his, and fed like his on "the corn of heaven," could so strenuously have sustained, he devoted whatever leisure he obtained from his official duties during the years 1818–22, to the study of the physical geography, ethnography, and history of Rajputana; and of the social, political, and religious system under which it had been governed by its famous princes; and to the collection of their genealogies and family legends, and traditions, as these are found epitomised and embodied in his "Annals and Antiquities of Rajasthan." This work is an inexhaustible storehouse of the known and accessible information of the Rajputs and of Rajasthan, as limited by the modern official Circle of Rajputana; and although in the present day its author's conclusions on certain moot points of obscure ethnology, and obscurer etymology, may be questioned, it remains the standard history, and will always remain the classical history, of Rajasthan. It is simply amazing how its author could have amassed the materials for its production, and reduced them from chaos to the fair and lucid order in which they are found in his pages, and within the years, which were also otherwise well-laboured years, of his all too brief life; for he died, as Colonel Tod, in 1835, at the age of fifty-three. But the work, contained in two bulky volumes, in imperial 8vo, has long been out of print, and is rarely to be found even in the catalogues of the sales of second-hand books. Moreover, it is too solid and preoccupying reading for the present day of superficial knowledge and professional culture. It is "*caviare* to the general," and outside the British Museum and our University Libraries it is now to be found only in the houses of families that have inherited copies from relatives connected with the Honourable East India Company; standing beside the treasured "Oriental Memoirs" of James Forbes, the grandfather of Montalembert, the "History of the Mahrattas" of James Grant Duff, the father of Sir Mountstuart Elphinstone Grant-Duff, and the "Ras Mala" of Alexander Kinloch Forbes: three books that everyone responsibly associated with the Indian Empire should read, and ever keep beside him, or for ever hold his tongue off India.

Miss Festing's "From the Land of the Princes" would, therefore, have been more than justified if only for its attracting wider attention to a work of such rare originality and authority as Tod's "Annals and Antiquities of Rajasthan," a veritable "Open Sesame" to the heart and mind and soul of the great, and sacro-

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sanct military caste of India; and the only Hindu caste with any inspiring and controlling traditions of political power and responsibility. But her handy volume has its own independent value, in the very qualification of affording a clear insight into the character and ideals of the Rajput Princes, which renders Tod's two unwieldy volumes invaluable for those who would acquire a true understanding of the people of India. Her collection of stories is all of definite, and unimpeachable family traditions and documents, selected with careful discrimination, and in the diligently observed order of their proper chronology and topography; and in the things that are profitable for inspiration and example, and therefore alone essential to historical teaching, they are faithful transcripts in prose of the *rashas*, or "bardic annals" of Mewar, Marwar, Amber (Jaipur), Haraoti [Bundi and Kotah], and Jeisalmir. Miss Festing's book, therefore, cannot but exert a salutary influence in promoting in this country a more intimate knowledge, and a more intelligent understanding of India, and arousing among us a feeling of generous and romantic sympathy with the noble *Kshatriya* caste of Rajputs; and of radical brotherhood with the "twice born" castes of Hindus generally, Brahman, and Rajput, and *Vaishya;* who in blood, and brawn, and bone, and in their ineradicable virility, are one and the same Aryan people with ourselves. The very word that labels our ethnical unity with them is taken out of their own mouths, and in its original sense; and amongst the earliest derivatives from it are the Sanskrit and Old Persian words signifying "brave" [*cf.* the Greek War-God Ares], and "truthful," and "noble" [*cf.* Greek ἄριστος] and "friendly."

THE ARYAS IN INDIA.

The Aryas of the prime, as they descended on India from the "officina gentium," some vague where about the Euxine, Caspian and Aral Seas, the "seething pot, and the face thereof toward the North" of the perfervid vision of the prophet Jeremiah, may have been mixed of all the ethnical stocks, Caucasian or Noachian, and Scythian* of Central Asia; but without doubt they were predominantly of the Aryan or Japhetic stock, speaking the language from which Sanskrit and Zend [Old Persian], Greek and Gothic [Teutonic], Latin and Romance have all been derived. As they pushed farther Eastward across Hindustan, and later Southward, down into the Dakkan, "they set up everyone his throne by the way," subjugating to themselves the Caucasian Hamites [represented by the Dravidas of Southern India] and Turanian ["Yellow" Scyths] and Nigritian [Negroid] peoples already in the peninsula. And as their paramount position was thus consolidated in the country, two things happened. They were no longer an army on the march. They had formed larger and smaller settlements, needing only a central garrison for their defence. Multitudes of the warriors thus fell out of occupation, and these, turning their energies to trading, in the process of the centuries became the *Vaishya* caste of Brahmanical India. It was a straightforward, frank solution, of a pressing economic problem. But the development of the reproductive resources of a country, and of mercantile relations with contiguous countries, has ever had a humanising influence on man; and the initiation of this process of national and social evolution by the unemployed Aryan warriors in India, proved the beginning, as in a grain of mustard seed, of the implacable and destructive conflicts that were to rage for centuries in a far-off future between the commercial and internationalised Buddhists, and the priestly and emmordantly nationalised Brahmans, when as yet there were none of either of them. At first every Arya was a king and priest unto himself, his family, and his state. But now and again a poet of genius had appeared among them, chanting his own improvisations to cheer his comrades on their ceaseless marchings and counter-marchings, or to rouse their courage on "the Field of Slaughter" to its highest fire. The "Hymns" of the *Rig-Veda*, the only true *Veda*, are the lyrical heart-burst of the devout joy of the Aryas [a transport of religious emotion that thrills the world to the present day], when, after their weary wanderings among the inhospitable uplands of Persia and Afghanistan, they at last stepped down into the immense extended, well-watered, and semi-tropical plains of the Panjab. A special reverence was rendered to such gifted men, and was continued to their children, and children's children, as the keepers, locked up within their trained and specialised memories, of these psalms and hymns and spiritual songs; now regarded as, in themselves, the ever-living Word of God, and

* The Scyths of classical writers were not unmixed Turanians, or "Yellow-men." The "Royal Scyths" of Herodotus have many Aryan characteristics; and the Turks and Indian Mo(n)gols can hardly be distinguished in their physical, emotional, and intellectual features from pure Aryas. The true "Yellow," and the true Black races, are outside the Caucasian [Aryan, Hamitic and Semitic] or Noachian Pale, and the genealogies of Noah.

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as arming their custodians with the prerogatives of actual divinity. The remaining fighting Aryas becoming more and more preoccupied with their administrative and military duties, whether as sovereign rulers or feudal vassals, the hereditary guardians of the Vedas, or sacred *rashas*, gradually monopolised the service of the priestly duties theretofore incumbent on every Arya to discharge personally, and thus became gradually segregated as the caste of Brahmans from the similarly differentiated castes of *Kshatriyas* and *Vaishyas*. The usurping Brahmans, in their sacerdotal intolerance of the natural superiority of the Rajputs, sought to brand them with an artificial inferiority, not only by writing them down second in the order of their four theocratic castes, but by striving, and on the whole with remarkable success, to impose upon them all manner of ceremonial disabilities. This is already indicated in the *Aitariya Brahmanam*, an Appendix to the *Rig-Veda*, giving for the guidance of the Brahmans the earliest glosses on the Sacrificial Prayers of the *Veda*, with speculations on their origin and explanations of their ritual. The English translation of this *Brahmana* by Martin Haug was published by the Government of Bombay in 1863, and in Book VII., chapters iii. iv. and v., and Book VIII., chapters ii. iii. iv. and v., we have a clear insight of the means used by the Brahmans, as increase of appetite grew by what it fed on, to magnify their sacred office, and exalt themselves over the Rajputs, not only in the sphere of their spiritual life, but in the very domain of their inherent and indefeasible temporal authority and power. The story of Parasu Rama, "Rama of the Axe," who "cleared the Earth twenty-eight times" of the *Kshatriyas*, and gave it—India—to the Brahmans, is another myth of the immemorial rivalry between the Brahmanical hierarchy and the *Kshatriya*, or Rajput regal straticracy.

The Fire-born Rajputs.

The irresoluble hostility of the Brahmans toward the *Kshatriyas* is shown also by the much later myth of the origin of the Agnikulas or "Fire (born) family" of Rajputs. They are said to have been raised by the royal and saintly Agasthya, the reputed author of so many of the "Hymns" of the *Rig-Veda*, from a sacramental fire kindled on the summit of Mount Abu [Arbuda], in the presence of a convocation of the whole college of Brahmanical gods. These Agnikulas are:—(1) the Paramaras, Pramaras, and Powars or Puars, *i.e.*, "Premiers," of whom Chandragupta, the Sandracottus of the Greeks, and the illusive Vikramaditya, the great champion of the Brahmans, are both claimed as members; (2) the Pariharas, formerly of Marwar and Idar, but now found only in Central India, and the Dakkan; (3) the Chalukyas or Salunkis of ancient Ayodhya [Oudh], and mediæval Saurashtra [Kathiawar and Gujarat, called also Valabhi or Balabhi], who are still represented by the Bhagela Rajputs of Rewa, the Jhala Princes of Drandgra, Limri, or Limdi, and Wadwan in Kathiawar; and (4) the Chauhans of Rajputana and Malwa, of whom Prithvi-Raj of Delhi, Ajmir, and Lahor, the Paladin of the Rajputs in their earliest conflicts with the Mahometan invaders of India is the most illustrious name, and who are at this day represented among the rulers in Rajputana by the Deoras of Sirohi, and the Haras of Haraoti [Kotah and Bundi]. The legend probably refers to the enlistment in the third and second century B.C. of Zoroastrian Persians, and Pagan Greeks into the *Kshatriya* caste, as supporters of the Brahmans against the older recalcitrant *Kshatriyas;* or it may be simply an allegory of the hallowing of the warrior caste by the fire of their lives of devoted self-sacrifice. According to the traditions of the Rajputs, who claim to be descended from the *Kshatriyas* of the primitive Aryas of India, these are still represented in Rajputana, in the Solar-line, by (1) the Grahilot, Gehelot or Sesodia Princes of Mewar [Udaipur], Dungarpar, Bansvara, and Shapura,—and the Gohil Princes of Bhavnagar and Palitana in Kathiawar are of the same clan; (2) the Kuchwaha Princes of Amber [Jaipur]; and (3) the Rathors [originally from Kanauj] of Marwar [Jodhpur], Kishengahr and Bikanir; and in the Lunar-line, by (1) the Bhati Princes [descended, in the pedigrees of Yadavas or Jadons, from *Krishna*, the "deus ex machina" of the *Mahabharata*] of Jeisalmir; and (2) the Jadija or Jharija Princes of Cutch, Gondal, and Morvi, in Kathiawar. Nevertheless, the Brahmans persist with the calumny that none of the primitive *Kshatriyas* survived the massacres of "Rama with the Axe," and that the Agnikulas, of their own creation, are the only Rajputs now existing in India. The contention is absurd. The Rajputs, who never lost their pride of Aryan race, never hesitated to recruit their ranks by the admission of desirable aliens from over "the North-West Frontier," whether Greeks, or Sassanian Persians. A Greek prince is traced in the genealogical list of the Rathors of Kanauj and Mewar; and, in the

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fifth century A.D., one of his successors married the daughter of Barham Gaur [Varanes V.]; and there is a tradition among the Gehelots of Mewar of an ancestress in the sixth century A.D. who was the granddaughter of one of the Christian Cæsars of Byzantium. My own opinion, based on personal knowledge of the men themselves, is that the purest Aryas of India are to be found among the Jainas, descendants of the Aryas who became *Vaishyas*, and then, influenced by the tenets of Buddhism, formed themselves into the heterodox sect of Vaishnava Hindus, named after "the twenty-four Victorious Jins" [*cf.* Arabic *jinn*, and "genii"], or deified saints, the objects of their especial worship. They form the prosperous and highly influential community of merchants and bankers known everywhere in Rajputana, Malwa, and Gujarat, by the style and title of *Mahajans;* and, soiled with all ignoble use by the money-lenders who have made the name of *Marvari* a byword throughout India, the appellation means, and still upholds, the ideals of a "great gentry."

The National Præcognita of Rajput History.

Apart from coins, and inscriptions on temple walls and other enduring structures, and a vast number of "copper plates" commemorating grants to temples, and the registers, ledgers, and similar documents accumulated in the current business of administration, constituting the *chalta daftar* [literally "walking parchments," *cf.* διφθέρα of Greeks] used by Grant Duff when writing the "History of the Mahrattas," the Hindus possess few authentic records, provided by themselves, of their own history; and, in attempting to reconstruct it, we have to depend on the arbitrary references to past events to be found, generally mythologised out of all recognition of their real form, in the *Vedas*, *Puranas* ["Olds"] and other sacred scriptures; and in such secular romances as the *Prithviraj Chauhan Rasha* of Chand Bardai, the Poet Laureate of the last Hindu King of Dehli; the *Raja Tarangini*, with its continuations [the *Rajavali* and others], of the Rajas of Cashmere, in the Kaurava line of the Lunar *Kshatriyas;* and the *Raja Tarangini* of Amber [Jaipur], giving a similar list of the Kings of Indraprashta or Delhi, from Yudisthira, the eldest of "the Five Pandavas of the *Mahabharata*," to Vikramaditya of Ujain and Delhi, composed so late as the early part of the eighteenth century, for Savai Jai Sing, the builder, all in white marble, of the gracious city of Jaipur. Mere facts, even the obvious convenience of cardinal dates, are quite beyond the scope of history as understood by Hindus, to whom its teachings, as apprehended and applied by themselves, would seem to have been all they ever cared to heed; and wrested from the truth, and allegorised for doctrinal purposes as the actual events dealt with by them may be, this having been done with the sincerity of religious zeal, they have intuitively expressed their grateful sense of the dealings of Divine Providence with them, as a favoured people, in devotional, and epic, and ballad poetry, singing and making melody in their hearts to the great gods to whom they raise their soul-moving and animating strains of exaltation and blessing and glory in the highest. The composite "Sesostris" [Seti I. and Ramses I., II., III.] of the Greeks may have sent a naval expedition against Western India; Darius Hystaspes certainly stretched out his sceptre over North-Western India, or Sindh and the Panjab; but there is no definite date in Indian history, before that transmitted to us by the Greeks, of the crossing of the Indus near Attock ["the Limit"], in the midsummer of 329 B.C., by Alexander the Great; while the continuous history of India, the earlier chapters of which we owe to the Mahometan writers of Arabia and Persia, only begins with the momentous apparition of the conquering armies of Islam in Sindh, A.D. 711; at the very time [A.D. 713] that another Muslim army, under its one-eyed leader Tarik ibn Zayad, was striding the Straits of Gibraltar, "the Hill of Tarik" into Spain.

The thousand years [1,037 years] between the advent of the Greeks and that of the Mahometans in India is a period of intolerable confusion for the systematic historian. But, viewed in the light of the following millennium [1,111 years] of "the Mahometan Terror" in India, the conclusion is justifiable that the previous period was also ennobled by the like dauntless and indomitable resistance of the *Kshatriyas* to the Scyths—whether of the Turkman or the Mo(n)gol races, who then commenced to pour ceaselessly into India—as in after centuries they opposed to their Mahometan conquerors. The shadows of the mighty names of the period are, (1) Chandragupta [316–292 B.C.],—variously regarded as a Lunar *Kshatriya*, an Agnikula, and a *Vrishala*, or *Kshatriya* degraded to the status of a *Sudra*, for neglecting the service of the sacred rites,

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and to consult the Brahmans,—the "Sandracottus" who drove the Greeks out of the Panjab and Sindh, and married the daughter of Seleucus I.; (2) his grandson Asoka [260–220 B.C.], the wilier Constantine of Buddhism; (3) Kaniska, with the assigned date of 40 B.C., another patron of Buddhism, whose reign marks the culmination of the political ascendancy of the Scyths,—Dhes [Dahæ], Jats [Getæ, Goths], Hunas [Huns], and others—in India; (4) Vikramaditya, *i.e.*, "The Blazing Sun" of Righteousness, the Melchizedek of the Hindus, surnamed Sakhari, "the (slayer) of the Scyths" [Sakas or Takas]; and (5) Salivahana, a Mahratta potter of Paithan in Maharashtra, also surnamed Sakhari, from whom the Rajputs of Bezwara are descended. Both Vikramaditya and Salivahana are held to have been contemporaries with Kaniska, and are both revered by the Brahmans as persecutors of the Buddhists, and the unresting, strenuous, and ever victorious assailants of the Scyths. Yet "the Saka Era," so named in honour of Salivahana, "the Slayer of the Scyths," commences A.D. 78, and the "Samvat Era," established in honour of Vikramaditya, commences in 57 B.C.; while the bloody battle of Korur, in which the Scyths were finally brought down by Vikramaditya from their paramount political position in India, is dated by the expert chronologists of Europe between A.D. 524 and 554. Of such are the bewildering entanglements, obstructing the symmetrical treatment of Indian history between the exit of the Greeks from the darkened stage, and the entrance upon it of the Mahometans. The Brahmans utterly ignore the invasion of Alexander the Great, and we only know that they did at the time recognise the presence of the Greeks in their midst from their including in their list of *Vrishalas*, a people they call the *Yavanas* [compare "Javan"], by whom they undoubtedly indicate the Greeks [*i.e.*, "Ionians"], although this designation is found to include the Scyths, and even the Mahometans of Hindustan: in short, any *mlecha*, or white-faced "barbarian" from the North or West of India. In the form of *Jonakan* it is still applied in Southern India to the Mopplas of Malabar.*

THE ISLAMITES IN INDIA.

I. THE ARABS.

Within four years of the death of "the Prophet of God," A.D. 632, the Caliph Omar built Bassora, in order to control the course of the lucrative trade of India, Persia, and Arabia with Europe; and in A.D. 647 the Caliph Othman sent ships from Bassora to reconnoitre the coasts of Western India between Broach, representing ancient Barygaza, the port of Saurashtra, and Tanna, in mediæval times representing ancient Kalayana, and itself represented in our modern days by Bombay, the great emporium of Maharashta, and the commercial and intellectual, although not the titular, capital of British India. But the Arabs, a Caucasian or Noachian race, and highly intellectual people, who had with the keenest alacrity and zest entered into the inheritance of all the wisdom of the Greeks, alike in the arts of war and peace, at once perceiving that before the opulent prize of India could be appropriated with any hope of its undisturbed retention, Afghanistan, the Barbican, or "Antemural" to the "Bayley-yard" of Hindustan, had to be permanently occupied, the Caliph Muaiwah I., A.D. 664, equipped an enormous army for the conquest of that country; a prescient and sagacious task, to the accomplishment of which fifty years of arduous and steadfast fighting were doggedly devoted; although in vain, for any perenduring advantage it was to bring to the Arabs. A detachment from the force was at the same time sent, in charge of Mohalib, to make a reconnaissance of the approaches into Sindh; and when the military and religious reduction of the Afghans was sufficiently assured, the Caliph Walid I., after a survey of coasts of Baluchistan, Mekran, and Sindh, in A.D. 705, in A.D. 711 fitted out a naval expedition, under the command of Muhammad ibn Kasim, acting in co-operation with Hijaj, the Governor of Bassora, for the subjugation of Sindh. Muhammad Kasim sailed boldly up the Indus to Bakkar [some say he landed at Deval, "the Temple," near the modern Karachi], and thence marched on Alor, and after a brief campaign annexed the whole of Sindh, from the delta of the Indus to Multan, to the Ommiad Empire of Damascus. Dahir, the Rajput Deshpati, that is, "Despot" [*desh*, "land"; *pati*, "lord"], of the country made a most determined defence; but in every implement of war he was hopelessly "outclassed" by the newly-gotten "Greek science" of the Arabs. There is presented to the eye all the picturesque pageantry of Agincourt, as illuminated on the pages of Michael Drayton, the brave show in the brilliant sun of lines upon lines of glittering steel, and of flapping

* I have been greatly assisted in working out this paragraph by Mrs. W. R. Rickmer's "Chronology of India," a work that calls for the most grateful acknowledgments of all students of Indian history; and worthy of a daughter of the great Free Kirk Missionary to India, Alexander Duff.

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banners, and fluttering banderolles, of every "tincture," each with its own "armings,"—not one

"But something had pight that something should express,"—

and of gorgeous trappings and caparisons of horses and horsemen, and camelry, and towered elephantry, all in solid array; and, as "the drums begin to yell," the sudden tumult and shoutings in the ranks, and the rush and clatter of hoofs, and the flash and crash of arms at close quarters, with the confused battle swaying backward and forward, as

"The Trumpets sound the Charge and the Retreat,
The bellowing Drum the March again doth beat."

But it is not war; and with the setting of the sun all that gay and gallant chivalry of Sindh of the *Kshatriyas* is seen rolled in blood and dust; and the tragedy of Alor closed with burning and fuel of fire in the terrible and woeful Rajput rite of the *johur* [Hindi *júhar*, from Sanskrit *yódhri*, "warrior"]. Dahir fell fighting in the thick of the Arab cavalry; but his widow continued the defence of the city until the exhaustion of provisions for the garrison. Then she, and all the women, with their children, gathered themselves together, and built up a great funeral pyre in the garden of the Palace, and, mounting it, were sacrificed in the flames of their own kindling; and the men having bathed and duly gone through the other ceremonies of the sublime "office," sallied forth, sword in hand against the enemy, and perished to a man. This is the immemorial Rajput ritual of the *johur*.

After Sindh, Muhammad Kasim annexed Gujarat; and thence marched on to Mewar. When, according to the vague traditions of the Hindus, Valabhi, now Vala, in Kathiawar, was stormed by a Persian king—Naushirvan the Great, 530–78, is the king named—the widow of the slain Rajput king, fleeing into the desert of Western Rajputana, there prematurely became the mother of a son [and heir to his father], known as Prince Goha. He established himself at Idar, and is said to have married a daughter of Naushirvan, by a wife who is said to have been a daughter of one of the Emperors of Constantinople—Maurice, 582–602, being the Emperor named. The seventh from the posthumous Prince Goha was Prince Bappa, who, on hearing that the Arabs had entered Mewar, collected a following, and inflicted a crushing defeat on them, and raised himself to the *gadhi* [literally, "a cushion," which, placed on a carpet, is a Rajput Prince's sovereign seat]: and it is from him that the reigning Ranas of Udaipur are lineally descended. The Arabs in India never recovered from this reverse; received at the very moment of their overthrow, at the other extremity of their far-stretched empire, by Charles Martel, on the glorious green fields between Poictiers and Tours, A.D. 752. The Rajputs in Sindh rose successfully against them in 750; and on their attempting to re-enter India from Kabul, under the command of the Mahometan Governor of Afghanistan, a relative of the Abassid Caliph, Harun al Rashid, the Rajputs at once set out against them, and, led by Prince Khoman of Chitor, finally expelled them from the sacro-sanct soil of India, A.D. 812. The Arabs were, in fact, at this time paralysed at the very centre of their power by the suicidal struggle ending, A.D. 750, in the extinction of the Hellenised Ommiades [saving the few who escaped into Spain, and renewed at Cordova the splendours of the Saracenic art of Damascus], and the transfer by the triumphant Abassides of the seat of the Caliphate to Baghdad, A.D. 763; a fatal error, for through it they lost touch with the stimulating West, and were brought completely under the debilitating and demoralising influences of the East; and were thus led on into abandoning the military defence of the Empire to mercenaries, until in the thirteenth century "the Caliphate of the East" found its dishonoured grave in "golden Baldac." For again the Scythians, now known as Turks and Mo(n)gols, - issuing forth, first as free-lances, and then as ravening conquerors, from the frost-bound steppes, and hills of ice, of the uttermost north, the Uttara-Kuru of the Hindus, once more swept away the undermined fabric of Semitic civilisation in Anterior Asia, and of Aryan civilisation in India and Eastern Europe—as though they had been but the glory of an hour. The Caucasian races have always rapidly spread themselves along the course, the "litus Aryanum" of the immemorial overland commerce between India, its perennial fountain-head, and Europe; and the great catastrophes of civilisation have resulted from the intersection of this line of human progress and culture by secular cataclysms of Negroes from Inner Africa into Hamitic Egypt, and of Turanians [in the phrasing of mediæval legends, the impure "Shut-up-Nations" of "Gog and Magog"] from Posterior Asia into Semitic Anterior Asia, and Hamitic Egypt, and Aryan India, and Persia, and Europe; isolating Caucasian civilisation in separate compart-

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ments, from the Ganges and Indus to the Danube and Nile. And the pity of it is that these humanising nations have never since the time of Alexander the Great been again joined together in the same mind, and the same judgment, living in peace together, as men drinking from one "Loving Cup"; and armed with the omnipotence of their unity alike against the "Yellow Peril," and the "Black Peril." This is the unplotted tragedy of the Old World, on which the curtain has never yet been rung down.

II. THE AFGHANS.

The decline of the Arab Empire became manifest immediately after the death of Harun al Rashid, the contemporary and friend of Charlemagne, when one after another the provinces of the Eastern Caliphate began to throw off their allegiance to Baghdad. The Turkman, Ismail Samani, possessed himself of Transoxiana, Persia, and Afghanistan, setting up his throne in Bokhara. The fifth in descent from him appointed his "favourite" Turkman slave, Alptegin, Governor of Kandahar; where, on the death of his patron, he asserted his independence; leaving his kingdom on his own death, in 979, to his "favourite" Turkman slave and son-in-law, Sabuktegin. Jaipal, the Rajput Prince at Lahor, suspecting the designs of his minatory neighbour, resolved to anticipate them by himself seizing on Afghanistan; but, brought face to face with Sabuktegin at Lagman, on the road from Peshawur to Kabul, not far from Badiabad—where Lady Macnaughten and Lady Sale were held captive in 1842, a sudden storm in the mountains caused a panic among his superstitious warriors, and reduced him to the humiliation of purchasing his retreat by the surrender of his elephants, and the promise to pay a pecuniary indemnity. On the sinister advice of his Brahman priests, he deliberately broke his word of honour; when Sabuktegin, in his turn, marched off for Lahor, and, coming upon Jaipal on the plain of Lagman, inflicted a disastrous defeat on the unfortunate Prince; notwithstanding that his large army was now swollen by contingents from the allied Rajput States of Ajmir, Delhi, Kalinjir, and Kanauj.

The son of Sabuktegin, the fierce and avaricious bigot, "Mahmud of Ghazni," maintained the quarrel of his father, and in 1001 defeated Jaipal with frightful slaughter in the Peshawur ["Frontier-ward"] uplands; permitting him to return to Lahor only on the condition of paying an annual tribute to Ghazni. The disgrace of this was too bitter for the misguided Prince, who, after agreeing to the terms imposed on him, solemnised his death in accordance with the Rajput "office" of the *johur*. Mahmud's second expedition was against the Prince of Bathia [whose State is now included in the Pattiala State], and here also the Prince Bijai Rai, when he found his courageous resistance vain, committed the imperative sacramental suicide of the *johur*. Mahmud's fourth expedition, 1008, was directed to the destruction of the powerful league formed against him by Anandpal, the son of Jaipal of Lahor, and supported with passionate patriotism by all the noble Rajput ladies of Hindustan. For forty days the rival hosts confronted one another on the wide pavilioned plateau rising westward from Peshawur to the Khaibar Pass, and when a general action was brought on by an irresistible charge of Cashmerian highlanders, and Anandpal seemed to hold the winged victory in his outstretched hand, the elephant he rode in his lofty estate, took fright at "the Greek fire" used by the Mahometans, and the panic thus caused turned the battle in their favour; 20,000 of the flower of the Rajput manhood being left dead on the field. Then, pillaging on his way the fabulously endowed shrines of Nagarkot, now Kangra, Mahmud went back to Ghazni, to gloat at leisure over his abounding booty of "barbaric pearl and gold." His sixth expedition was undertaken for the sack of the yet holier and wealthier shrines of Staneshwara, "the Throne of God." In his seventh and eighth expeditions, 1014 and 1015, he ravaged Cashmere. His ninth expedition, 1017, he carried right into the heart of Hindustan, creeping stealthily along the slopes of the Himalayas, as near to the river sources as possible, and suddenly presenting himself with 20,000 Afghan infantry, and 100,000 Turkman cavalry before the gay and joyous garden city of Kanauj. The Rajput Prince at once capitulated; whereupon Mahmud, after three days' rest, hurried on to the great Bhramanical shrines of Mutra, the birthplace of Krishna, giving them up to fire and sword and rapine and plunder for twenty days; sparing only the fabric of a few of the temples, because of their exceeding beauty. His tenth and eleventh expeditions, of 1022 and 1023 respectively, were of comparative unimportance. The former was successful in its punitive object, the deposition of Jaipal II., of Lahor, for inciting a Rajput campaign against the Prince of Kanauj for his submission to Mahmud without an appeal to "the fortune of war." The

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latter, directed against the Prince of Kalinjir, for assistance given by his predecessor to Jaipal I., of Lahor, against Sabuktegin, and by himself to Anandpal against Mahmud, proved unsuccessful. The twelfth, and last, and locally most vividly recollected of Mahmud's expeditions, was in 1024, when he trudged down across the sands of Sindh and Western Rajputana, a thousand miles to "the sack of Somnath" in Kathiawar. The Rajputs let him proceed on his outward march unmolested; but when he turned back, overweighted by the votive offerings of centuries, with his face anxiously set toward Ghazni, they dogged every turn of his flagging course through the desert wastes between the Luni and the Indus; leading him away from the sparse water-springs on the right hand and the left, and betraying him into every manner of ambages and ambuscades, until well nigh the whole of his bedraggled army was lost, and the greater part of his impious plunder. For the rest, he bilked the poet Firdausi ["the Paradisaic"] of his trivial pension [as others of us have been similarly bilked since then]; and in the very hour of his death wept on bidding farewells to his treasures of costly arms, and armour, and precious jewels; sternly controlling an occasional impulse to divide them among the loyal comrades of his retributive raids and other faithful friends. But he had a quick eye for great architecture; and, from a maze of squalid Turkman huts, he made Ghazni, with its "Palace of Felicity," and arcaded streets, and refreshing fountains, and its "Mosque of the Celestial Bride," the pride and boast of Central Asia. Therefore, one understands, after a passing emotion of amused surprise, the fitness of things in the fact that he died, if not exactly in the show and seeming, yet, and emphatically as regarded and judged by his contemporaries, in the full savour of sanctity. In a word, he was a man; and whatever he determined to do he did it right thoroughly. Furthermore, his fine feeling for architecture and for sumptuary objects of art, for all its taint of cupidity, must be accounted to him, and scarcely less than his leonine boldness, for the righteousness that exalteth a nation.

The First Afghan Dynasty, called of Ghazni, gave place, in the regular course of Afghan infamy, and perfidy, and treachery and murder, to the Second Afghan Dynasty, called of Ghor, 1153–1206; and Shahabudin, better known as Muhammad Ghori, succeeding to the *masnad* [the "cushion" and carpet throne of Mahometan rulers, Hindi, from the Arabic *sanada* "to lean against"], resolved on the conquest of Hindustan as a deliberate and definite policy. The moment was propitious for him. The Rathors of Kanauj had never been forgiven their ready surrender to Mahmud of Ghazni; and Ananda Deva, the Tomara Prince of Delhi, dying without male issue, and leaving his kingdom to Prithvi Raja, the Chauhan Prince of Ajmir, the latter, now uniting in his person the Tomara and Chauhan Rajputs, and the Sovereigns of Delhi and Ajmir, asserted his pretensions, against the prescriptive claims of [? his uncle] Jaya Chandra, the Rathor Prince of Kanauj, to be recognised as "the Over Lord," "Primus inter Pares," of the reigning Rajputs of Hindustan. This was bitterly resented by Jaya Chandra; who, taking advantage of the approaching marriage of his daughter, summoned all the Rajput Princes to be present on the occasion, and render him homage as their Lord Paramount. Prithvi Raja, who loved and was loved by his fair cousin, strong in his pride as in his affection, bluntly refused to demean himself as a vassal of Kanauj. Jaya Chandra, enraged, had an image of Prithvi Raja made in the garb of a door-keeper, and placed it at the entrance to the hall in which the nuptials of his daughter were to be celebrated. But he counted without the fair Sangagota, who, on approaching the hall, bearing the garland she was to place round the neck of the bridegroom selected for her, quietly turned, to the right and cast it over the head of the affronting image of Prithvi Raja. In a moment Prithvi Raja was at her side, and before the brilliant assemblage could recover from their amazement, had, with a sweep of his right arm, swung her up and across his saddle-bow, and galloped off with her, fast as his horse could bear them, all adown the rattling road to Delhi. It was Netherby Hall, and Young Lochinvar anticipated; and Sir Walter Scott was also there, in the person of Chand Bardai,* to immortalise the incident, so typical of the romantic and chivalresque life of the old Rajputs, "in Love and Arms delighting,"—in the "martiall *Pyrrhique* and the *Epique* straine" of the "Kanauj *Kandh*," or "Canto," of the *Prithviraj Chauhan Rasha*. Jaya Chandra, while sending his daughter her wedding trousseau [*jehaz*], called down on his son-in-law the wrath of the Afghans from Kabul and Lahor. Muhammad Ghori had, in

* The bard Chand actually flourished at this date; and although his authorship of the *Prithviraj Chauhan Rasha* has latterly been called in question, no reason whatever has been adduced for doubting the unhesitating tradition of the Rajputs on the point.

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1191, made an attempt on Delhi, but being promptly met by Prithvi Raja west of the city, between Panipat and Staneshwara, the traditionary battlefield of the Kauravas and Pandavas, he was there well defeated. But now, 1193, having strongly recruited his Turkman cavalry, he at once called them "to boot and saddle," and set off again for Delhi, with an invincible force. Betrayed by Jaya Chandra, and deserted by the Bhagela Rajputs Princes of Gujarat, yet supported by the Gehelot Rana of Chitor, Prithvi Raja was able to muster some 200,000 "cavaliers," and a proportionate number of "men-at-arms" to his colours. The two hosts came in sight of each other from the opposite banks of the River Sarasvati; Prithvi Raja having again chosen his ground, "the Field of the Kuravas and Pandavas" at Staneshwara, because of its auspiciousness among all Hindus, and its good omen for himself also. But the time passed by the Afghans in preparations for the coming battle, was wasted by the Rajputs, who trusted to the charmed ground whereon they camped, in athletic sports and feasting; when, one night, just before the dawn, Muhammad Ghori, crossing the Sarasvati, suddenly awoke the day with his drums and trumpets, and was upon the Rajput host before his approach had been observed. Prithvi Raja, however, soon got his army in hand, and was apparently pressing Muhammad Ghori to a second defeat, when the latter, feigning a general retreat, and the unsuspecting Rajputs—true Aryas in this respect—falling into the flagrant confusion of a reckless pursuit, he at once charged them with the whole élite body of his hitherto masked cavalry, called up from the right and the left against the heroic Prithvi Raja. For miles "the stricken field" was strewn with cast-away flags, and spears, and shields, and heaped bows and jeweled swords, and plumed casques, and gauntlets, greaves, and breastplates, exquisitely chiselled, and damascened, and gaily dyed scarves, all commingled with the blood of the countless dead. For it was not only the number of the dead that lay there that was so portentous of evil to come, but their position, their power, and their princely worth. Prithvi Raja, fighting to the last, his sword still in his hand, refusing all surrender, although surrounded on all sides, and virtually a prisoner, was cut down in cold blood. His youthful bride immolated herself on his funeral pyre. The Prince of Chitor shared in his death; and with them also fell 150 of the purest and best "bloods" of all the Rajput nobility of India. It was the Flodden Field of Rajasthan; and for 600 years India, India of the Hindus, never recovered from that "doubly redoubled" deadliest stroke of doom; not until England stepped forward to revindicate her Aryan liberties from Turanian slavery and oppression. Storming Ajmir, and massacring its garrison, Muhammad Ghori, in 1194, passed on to Kanauj, which fell an easy prey to his arms; most of its defenders being driven into the Jamna, with the brave old Jaya Chandra at their head, "bearing up their chins" to the last. When recovered his body could only be identified by his case of false teeth, held together by gold wire.

In the dramatic contrasts of its opening and closing scenes, surely never was a tragedy, not even of "the House of Atreus," of deeper or more moving woe. It is the story of Juliet and her Romeo, but involving in the pathetic fate of these Rajput lovers the doom of a great mediæval Aryan Empire; presenting Aryan civilisation and Aryan culture in a brighter, happier—because more natural—and simpler form than it had taken since the days of Alexander the Great, or will ever take again, for it was still Greek in outward form as well as in its sentiment and vitalising spirit. No wonder that the story inspired Chand Bardai to sing his undying requiem of the Rajput race.

The scattered remnants of the reigning families retired through the defiles of the Jamna into the sequestered recesses of the Aravali Hills, and the even more secretive solitudes of the salt desert between the Luni and the Indus; Rao Sivaji, the grandson of Jaya Chandra, settling in Marwar, with his capital at Mandor.

The conquests of Gujarat, Oudh, Bengal, Bahar followed, and by 1206, the date of Muhammad Ghori's assassination, the irregularly and loosely organised rule of the Afghan Mahometans extended over all Hindustan, or India north of the Tapti and Nerbudda Rivers, and the Satpura and Vindhya Mountains.

On the death of Muhammad Ghori, one of his "favourite" slaves seized on the government of Afghanistan; and another, his ablest general, Kutubaddin, on that of Hindustan, and founded the Third Afghan Dynasty of India, called of "The Slave Kings," 1206–88, with their throne at Delhi; where the Kutub Minar commemorates his name. During the reign of his successor, Chinghiz Khan appeared on the banks of the Indus, and again between 1246 and 1266; and during the latter period an embassy was sent to Mahmud II., the eighth of "The

Slave Kings," from Hulaku Khan, the destroyer of Baghdad, a grandson of Chinghiz Khan, and brother of Kublai Khan "in Xanadu." However, the only events of this period directly connected with Rajputana were the capture of the hill fort of Rintambor in the Jaipur State, and a rising of the Princes against Balin, the ninth "Slave King," 1266–88, said to have been quelled in an immense slaughter of the Rajputs.

The Fourth Afghan Dynasty of India, called "The House of Khilji," was founded on two assassinations by the Khilji chieftain Jelaluddin in 1288. He was succeeded, after the assassination of his two sons, by his nephew Allauddin Khilji, "The Sanguinary," whose reign is memorable for a great raid of the Mo(n)gols on Delhi, 1298; and for the commencement of the regular subjugation of the Dakkan and the Carnatic. Risings of the Rajputs were put down by the reduction of Gujarat, 1297, the capture of Jeisalmir in 1294, the recapture of Bintambor in 1300, and the siege and sack of Chitor, 1303–5. The Gehelot Prince, driven to despair, resorted to the awful rite of the *johur*. His queen, Padmani, a woman of notable beauty, with all the ladies of the Court, and the wives of the warriors, built up a vast funeral pyre in the centre of the city, and "so passed, as in a chariot of fire, to the Heaven of Indra"; and all the men rushed out through the gates upon the besiegers, who cut down the most of them on the spot, a few only escaping into the overhanging Aravali Hills. This is "the First Sack of Chitor," of the three great "sacks" of that city. With the poisoning of Jelaluddin by his "favourite" slave and trusted general, Malik Kafur, and the murder of his third son and successor by his own "favourite" minister, a vile *parvari* [compare the Greek πάροικος, "parishioner"], an outcast from Hinduism, and a pervert to Islam, the House of Khilji came to its hideous end in 1321.

The Fifth Afghan Dynasty in India, called "the House of Tughlak," from its founder, Gheiazuddin Tughlak, Governor of the Panjab, the son of a Turkman slave by a Jat mother, reigned in a succession of seven kings from 1321 to 1412. This period is marked by the rebellion of the Mahometan Governors of the Provinces of the Empire against the central authority at Delhi, and by the terrifying advent of Timurlangra, "Timur-the-lame," "Great Tamburlame," at Attock, September 1st, 1398. He swept through Hindustan like a devastating whirlwind; and, on being proclaimed Emperor at Delhi, after massacring 100,000 prisoners in cold blood, in jubilation over the occasion, and going in state to the noble mosque of polished white marble on the banks of the Jamna, "to render to the Divine Majesty his humble tribute of fervent praise for the signal honour done him," he recrossed the Indus, in March, 1399, in the same unexpected way as when he entered India just six months before; taking with him the massed, incomputable, and incomparable pillage of Delhi, Mirut and Hardwar.

The Sixth Afghan Dynasty, called "The Four Seiads," 1414–1450, ruled at Delhi as Viceroys of the Mo(n)gols; and the Seventh, called "The Three Kings of the House of Lodi," 1450–1526, was the last of the abhorred Afghan dynasties of India. Altogether, they had torn and battened on India, like devouring dogs, 320 years.

III. THE MO(N)GOLS.

The Afghan Governor of Lahor, himself a Lodi, having revolted from Ibrahim Lodi, the last of his dynasty, called in the aid of Zahiruddin Muhammad, surnamed Babar ["Baber"], "the Lion Hearted," hereditary Khan of Kokan. He was the sixth in descent from Timur, and, on his mother's side, a descendant also of Chinghiz Khan. Having occupied Kabul in 1504, and Kandahar in 1522, he readily responded to the invitation of Daulat Khan Lodi; his first act, after crossing the Indus, being to seize and depose the disloyal Daulat Khan, as an untrustworthy person to leave on the line of his communications with Central Asia while on the march to Delhi. Baber had only 20,000 men with him, but mostly Turkman cavalry; and when he found himself barred at Panipat by Ibrahim Lodi with an army of 100,000 men and 1,000 elephants, he at once extended himself, masking his cavalry on both flanks. He let Ibrahim Lodi exhaust himself in repeated attempts to rush the position, and then, at the psychological moment, slipping his élite cavalry on the disordered Afghan host, and assailing them on the right hand and the left, he struck down 5,000 of them on the spot, with Ibrahim Lodi in their midst. The rest of the rout, recoiling before his solid assault, like surging waves from a rock-bound shore, were rolled back in a headlong flight, and torrent of bloodshed, into the swift flowing, unheeding stream of the Jamna. In suchwise, on April 19th, 1526, was the second of "the Four historical Battles of Panipat" won and lost. The capture of Agra [compare "ager," a "field"], imme-

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diately followed. Henceforward, throughout the rule of the Mo(n)gol Emperors of Delhi [1526–1806, and nominally to 1857], the history of Hindustan passes into the open light of our own day, and need be no further traced here beyond its points of contact with the history of Rajasthan, as now contracted into Rajputana.

Neither the Afghans nor the Rajputs anticipated that Baber would remain in India after the plunder of Delhi and Agra. They expected that he would return like Timur, with the bloated burden of his bag and baggage, into Central Asia. He had, however, resolved to govern India in India; and forthwith set about the supersession of the rebellious Provincial Governors of the Lodis, and the resurgent Rajputs; entrusting this arduous duty to his eldest son and successor, Humayun. The Rajputs, when they found that Baber had come to stay among them, at once rose against him, in a last desperate effort to restore the *Kshatriya* supremacy throughout Hindustan. They were led by Rana Sanga the *Kalas* [compare "cœlus"], "the Pinacle—of glory" of Chitor, and the Rai of Jaipur, and the Rao of Jodhpur, and Medni Rai, a brave and enterprising Rajput cadet, who had recently possessed himself of the fortress and territory of Chanderi in Malwa. This patriotic league was shattered at a blow at the battle of Sikri—afterward called by the Mahometans Fatehpur, the "City of Victory"—February, 1527. Shortly after this, Bahadur, the Sultan of Gujarat, invaded Mewar, and storming Chitor, 1532, "the Second Sack of Chitor," the noble Rajput queen before celebrating the *johur* sent her bracelet to Humayun, to pledge him by this immemorial Rajput token of adopted brotherhood, to the protection of her son. The magnanimous Mo(n)gol at once marched against Bahadur, and drove him back into Gujarat. But Humayun, although brave and generous, was unenterprising, and was never free from troubles with the Afghans for the fifteen years of his reign, 1540–1555–6.

Jellaluddin, surnamed Akbar, "the Great," the son of Humayun, was, throughout his reign, 1556–1605, the contemporary of Queen Elizabeth, 1558–1603. He, or rather his faithful guardian and great general, Beiram, stamped out the Afghans, now led by a great *Kshatriya* general, Hemu, on the plain of Panipat, November 5th, 1556, "the Third Battle of Panipat"; and the following six years, 1567–73, were spent in the reduction of the again resurgent Rajputs. The first to submit was Bahara Mal of Amber [Jaipur], one of whose daughters had been taken in marriage (? 1561) by Akbar; and the daughter of whose son, Rai Bhagvandas, was married (? 1585) to Selim, the son and successor, under the name of Jehanghir, "the World Conqueror," of Akbar. Again, on the submission of Jodhpur in 1573, Rao Udai Sing gave up his sister Jodha Bai in marriage to Akbar. Raja Man Sing, another brave and ever faithful general of Akbar, was a member of the reigning family of Jaipur; and another *Kshatriya* Jodai Mal, distinguished as a general, was also a distinguished financier, and the greatest of Akbar's ministers. The great Emperor's employment of *Kshatriya* Hindus, in this way, in high office, and responsible military commands, served greatly to reconcile them to the rule of the Mahometans; and his marriages with the Rajput princesses also undoubtedly improved the physical vigour and the intellectual power of the offspring of "the Great Mo(n)gols," and tended to ameliorate the religious and social prejudices separating Mahometans and Hindus. But, at the time, the Houses of Jodhpur and Jaipur incurred much odium and contempt for permitting these family alliances. The Rana of Chitor resolutely refused to acquiesce in the degradation, as he regarded it, and defied the wrath of Akbar against his proud and scornful contumacy. He preferred death to what he deemed, and was deemed by all his peers, to be dishonour, and the foulest dishonour. Akbar accordingly laid siege to Chitor; when, there being no hope of deliverance, the *rani* solemnised the rite of *johur*. This is known as "the Third Sack of Chitor," 1567–68. Udai Sing, the Rana, on the approach of Akbar, leaving the defence of the city to Jai Mal, the Chief of Bednor, had sought refuge in the neighbouring forests, where he afterwards built the city of Udaipur; making a vow that so long as Chitor remained a ruin, neither he, nor his successors, would twist their beards in the Rajput fashion, or eat or drink from anything but leaves, or sleep on anything but straw; and to this day the Ranas of Udaipur sleep on sumptuous beds *laid on straw*, and eat from golden and silvern plates *laid on green leaves*, and never twist their beards.

By 1592 Akbar had made himself master of Hindustan, keeping a strong hold on Afghanistan, as the key to the plains of the Indus and Ganges; and he now commenced operations for the recovery of the lost Dakkan to Islam. But in 1601 his health seriously failed him,

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and the last five years of his life were overshadowed by the gloomiest forebodings for the future. He knew that he was a man superior to all the men about him; that there was none to carry on his work, that there was not one that even understood its full significance. He died in absolute mental isolation,—like that of the lonely eagle in its solemn flight at sundown to its upland arie. In truth he was not only the Greatest of "the Great Mo(n)gols," but pre-eminent above all his pre-eminent contemporaries in Europe; an ornament and pride not only of Islam, but of the human race. His transcendent name in India not so much rests on his conquests, as on his genius in consolidating them, and creating the organisation for their civil administration and military defence. He freely bestowed, or rather he enforced, religious toleration on his subjects; and could he have had his will of their hearts he would have broken down all social barriers between them. He advanced Hindus not only to the highest and most dignified, but to the most responsible and confidential appointments in the State: and never should it be forgotten that they served him with scrupulous and whole-hearted fidelity, and that the very loyalest of them were the strictest and most uncompromising devotees of their own religious beliefs and observances. He abolished the infamous poll tax on Hindus, he forbade *sati* ["suttee"], and encouraged the remarriage of Hindu widows. He severely repressed the attempts of the Rajputs to act independently in matters of high policy and State necessity; but so long as they were submissive in their political relations with the Paramount Power he not only respected their social prejudices, and sympathised with their misfortunes and aspirations, but treated them as valued and honoured and trusted friends; and he made the most advantageous uses of them for the purposes of imperial defence; not attempting to dragoon them into uniformity with the Mo(n)gol drill-books, but leaving them in their own national military formations, racy of the soil, as volunteer troops, who above all, horse and foot, were, every one of them, a gentleman, as it was of olden days with the Scots clansmen. He never interfered in any way in the internal economy of their sovereign States; and he never, in the benign intelligence of his capacious brain, conceived the thought of forcing an alien system of education on a people who, through at least 2000 years of history, had elaborated the most perfect type of Aryan speech, and created a splendid literature, and unique architectural and industrial arts of their own, and a highly spiritualised idiosyncratic religious culture. We may therefore the better understand the anguish of his dying years, 1603–6; the daily failing of his great heart for fear, and for looking forward to the evils that he saw were coming on the Mo(n)gol Empire when his own fate was fulfilled. He was constantly speaking to his family and his great nobles of the inevitable consequences of their mutual jealousies and rivalries, and of the imminent dangers of persisting in them; and exhorting them to concord and frank co-operation. But they were as words spoken to the wind that bloweth where it listeth: while at this very time, February of 1601—

"Riding in *Thames*, between *Lymehouse* and *Blackwall*," were the "Hector," "Ascension," "Susan" and "Guift," with the "Red Dragon" of the "First Voyage" of the first East India Company, freighted with the "unshunable destiny" of the English race in Asia; those who turned a deaf ear to the warnings of Akbar little witting that they were thus already preparing the way before it.

(To be concluded.)

AGRICULTURAL ASSOCIATION AMONG THE MOHAMMEDANS OF THE MAGHREB (MOROCCO, ALGERIA, TUNIS).*

The vast Colonial Empire of France in North Africa awaits its full development chiefly from the progress of agriculture: together with the factors of technical order, factors of an economico-social order also here assume constantly increasing importance, the relations between the land and man, the relations between the various agricultural classes, between the natives themselves, and between these and the colonists.

An article in the June number of the *Bulletin of Economic and Social Intelligence*, published by the International Institute of Agriculture, gives, as summarised from a learned work recently published by Louis Milliot, a brief indication of the character of these relations as they appear in the religious law of the Mohammedans and in their civil law, and of the forms in which they have asserted themselves throughout the various civilisations introduced by conquerors: in a word, of the characteristics and development of agricultural association among the Mohammedans of the Maghreb from the ancient family community to the modern forms of co-operation. It is well known that in the Mohammedan world the religious element

* Summarised from the *Bulletin of Economic and Social Intelligence* of the International Institute of Agriculture, Rome. Year III., No. 6. June, 1912.

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exercises absolute sway over all the manifestations of public and private life: thus law becomes confused with religion.

By the side of the religious law, however, under the pressure of new needs, a civil code has been formed which is often in conflict with the religious. This dualism is met with specially in connection with association, and the *fiqh* (religious law) has often had to give way before the *urf*.

Thus the severe prohibitions and limitations impeding the free development of the forms of association, which may be summarised under the heads of *usury* and *hazard*, were in practice relaxed so as to allow of the development of new types of association.

The four typical forms of agricultural association recognised as lawful by the religious law, but always surrounded by a series of restrictions, are the following: the *muzârâ'a*, or contract for collective sowing and cultivation; the *musâqâ*, or contract for collective irrigation; the *mughârasa*, or planting contract; and the society for livestock improvement. These contracts have in practice gradually been freed from their trammels, and have given birth to new accessory forms, from the society for grafting trees to that for the herding of animals. Further, while in religious law only societies aiming at profits were met with, in the law in common use many forms have appeared approaching to our agricultural associations, for collaboration and assistance, such as the co-operative *silos*, and the societies for rendering mutual service.

The society most frequently met with among the agricultural population of the Maghreb is the *kammâsâ* (society on the basis of a fifth of the profits), which is a form of the *muzârâ'a*: one of the members (the *fellah*) provides the land, the stock, the seeds, etc., the other (*kammas*) the labour. The latter receives a part of the crop, generally a fifth. Then come the *msaqa* and the *mgharsa*: the first extends to trees, cereals, vegetables, etc.: the *fellah* provides the land, the seed, the capital, the *kammas* the labour, especially for irrigation, and receives the half or the third, and sometimes, as in the case of date palms, the eighth of the yield. In the second (*mgharsa*), the proprietor places his land at the disposal of a partner for the plantation of trees, especially olive trees, on the condition that within a fixed time the ownership of a half or a third part of the trees and the soil shall pass to the latter.

The French conquest gave a violent shock to the primitive *régime* of the Maghreb, and hence also to the system of agricultural association: the era of peace and security introduced into the country has, on the one hand, relaxed the bonds between *fellah* and *kammas*, so that the latter has been transformed into a simple *métayer*; on the other, the increase of the native population, the absorption of the soil by Europeans, the reforms in the land system facilitating the sale of lands and the abolition of imprisonment for debt, have led to many *fellaheen* being reduced to the *kammas* class and others becoming labourers on wages, thus increasing the mass of the proletariat. This phenomenon has aroused a certain anxiety for the future of those regions; and the Government has sought how to restore among the natives, by means of special facilities and encouragements, the spirit of association and the old forms of societies best adapting themselves to the times, besides introducing those mutual and co-operative systems which have given good results in the mother country. So, for example, it has been attempted to introduce into every commune or *caidat* native thrift, mutual aid and loan societies, as developments of the ancient collective granaries: in Algeria there are to-day about 200 of these, with more than half-a-million members and 19 millions of capital, and in 1907–08 they gave loans for 9 millions for purchase of seeds, cattle, etc., at the rate of 5 per cent. for an average term of from three to eight months.

There have further been founded agricultural credit banks, mutual labour societies, and irrigation syndicates, which have given excellent results.

Private initiative at last has, on its side, promoted the foundation of various forms of societies, agricultural syndicates, co-operative societies for production, etc. Among others, the experiment of the "Setif Agricultural Comice" (Constantine), of native co-operative societies for the cultivation of lands conceded or leased deserves mention. Association, then, is destined to accomplish an important work in the agricultural economy and policy of French North Africa.

THE VANILLA INDUSTRY OF THE SEYCHELLES.

In the preparation of vanilla beans in the Seychelles, a successful result depends on the pods being picked at the right stage of maturity more than on anything else—that is, when they are ripe and just before they begin to split. An unripe pod will never prepare well, and is always inclined to become mouldy; split or over-ripe pods have lost much of their value. A pod in condition to be picked has lost to a great extent its shiny green colour, has become duller, with an almost silvery appearance. The longitudinal lines along which it will eventually split, if left, are distinctly marked. The tip is light in colour, or even yellowish, and comes away fairly evenly from the stalk when broken off. Pods in a bunch seldom ripen simultaneously, so they must be carefully watched. When brought in, the pods are sorted into five qualities—(1) over six inches long; (2) over four inches long; (3) under four inches long; (4) split; (5) unripe, broken, etc. A vessel of water is heated to 188·6° F.; the pods are placed in an openwork basket, and dipped for ten seconds, withdrawn, and allowed to drain for about five seconds; dipped again for ten seconds, withdrawn, and drained as before; dipped again for about five seconds, or until their colour has changed to a dark green. Large pods require

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a longer third dipping than small ones. After being scalded, the pods are wrapped in woollen blankets and left in a warm, dry place for twelve hours, when they have taken on a blackish hue. They are then placed in trays in a room heated to between 90° and 100° F., on one thickness of blanket, and covered by another. In about ten days the largest pods will have become wrinkled, the smaller ones before that. When in this state they can be removed to a cool drying room, where they are placed on trays uncovered, heaped on each other to a depth of three inches, and turned about every day. The more slowly vanilla is dried the better. When the pods are dry they are taken out and stored in a dry place in wooden boxes. They are examined thoroughly from time to time, to see that they show no signs of mould. A dry pod should have a silky feeling, the wrinkles must be soft, there must be no hard centres, and it should be possible to tie the pod in a loose knot without breaking it. Absolute cleanliness is observed all through the preparation, and those who handle vanilla are careful to wash their hands before touching it. When sufficiently dried, the pods are put into a vessel containing water at a temperature of about 80° to 90° F., and stirred with the hands for about five minutes, then taken out and placed in trays or on a blanket in the sun, where they soon dry. The pods are now measured and tied in bundles of sixty pods each, with two turns of flax thread in the middle only. Tin boxes are used in the Seychelles, thirteen inches long, nine inches broad, and six inches deep, a lining of parchment paper being placed in each. The vanilla must be packed fairly loosely, and the lid secured by solder.

THE PRODUCTION OF TALC IN THE UNITED STATES.

A new record was established in the United States in raising the annual production of talc or soapstone in 1910 to 150,716 tons, an increase of 16 per cent. in quantity, and 30 per cent. in value, compared with the production in 1909, according to a report issued by the Geological Survey in that country. There were eleven producing States—California, Georgia, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, and Virginia. The increase in production was chiefly in New York, whose output of 71,710 tons formed nearly half of the total production of the country. Talc is usually marketed as rough from the mine, sawn into slabs, and made up into manufactured articles, such as laundry tubs, or ground into powder. In 1910, 69 per cent. of the talc was ground, and 21 per cent. made into slabs and manufactured. The product of New York is practically all ground. Vermont ranks second, and produces both ground talc and soapstone. Virginia, the third in rank, produces some ground talc, but a large amount of soapstone, in the production of which it outranks all other States. Most of the ground talc is used in the manufacture of various kinds of paper. It finds application also in the manufacture of moulded rubber forms, and as foundry facings, and paints. It readily absorbs grease, and is used to remove spots from silk, and to bleach various articles. On account of its peculiar properties, it is widely used to lessen friction, and for this purpose it is dusted into gloves and shoes, and blown into conduits to ease the application of electric wires, or other conductors. One of its widest applications is in toilet powders, most of which are made from the finest talc imported into the United States from Europe. Laundry tubs, griddles, foot-warmers, and many other similar utensils are manufactured from soapstone. The higher grades of massive talc, free from flaws, are sawn up to make pencils or crayons, French chalk, and other special articles.

NOTES ON BOOKS.

Seasonal Trades. By Various Writers. Edited by Sidney Webb, LL.B., and Arnold Freeman, M.A. London: Constable & Co., Ltd. 10*s*. 6*d*. net.

At the London School of Economics and Political Science an advanced class of social investigation and research is conducted by Mr. Sidney Webb, with the assistance of Mr. Arnold Freeman. The students are taught to use the different methods of investigation and the principal sources of information, and are expected to write theses or monographs on the special subjects which they have been studying. The general subject investigated last year was "Seasonal Trades in the United Kingdom." Various trades were studied by different students, and in the present volume we have a series of monographs on seasonal trades in general, the tailoring trade in London, the waiter, the cycle industry, the gas industry, the London millinery trade, the skin and fur trades, the boot and shoe trade, and the building trade. Although these chapters of "students' work," as Mr. Webb calls them, prepared amid the stress of examination and other pressure, fall short of the highest standards of scientific investigation or economic scholarship, they represent, as he claims, a considerable amount of patient, original, and independent research, and contain a great deal of really valuable information.

But perhaps the most interesting, if the briefest, portion of the book is the preface by Mr. Sidney Webb, in which he points out that though each particular trade may be seasonal, still, "taking all the industries of the United Kingdom together, there is no such striking difference in the total volume of employment from one month to another as is commonly supposed." The statistics of the Board of Trade show that if there is no month in the year when some great industry is at its slackest,

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there is also no month in the year when some great industry is not at its busiest. Thus, while January is the worst month in iron-mining and the furnishing trades, it is the busiest at the docks of London, and one of the busiest for coal-mining; in February the plumbers suffer most from unemployment, but it is the best month for the paper-makers; March and April are bad months for the coopers, but the best for steel-smelters and the textile and furnishing trades; and so on through the whole tale of the months. To sum up in Mr. Webb's own words, "there is, in the United Kingdom of to-day, no seasonal slackness in the community as a whole." From this he draws the conclusion that the seasonal alternations of over-pressure and slackness, which press so disastrously on many classes of workers, are not inevitable in the nature of things, but are "due only to failures of adjustment .... They mean only that our statesmen have not yet given themselves the trouble to make the social adjustments and to employ the various devices by which these calamitous dislocations of the lives of so many hundreds of thousands of households can be prevented."

As to the nature of these adjustments and devices the present volume says little, nor does Mr. Webb think it the duty of his seminar to discover any practical plan for preventing seasonal unemployment. He is concerned at present with training investigators who will be able to study the causes, and this is obviously the first step towards any satisfactory solution of the problem.

Victoria and Albert Museum: Review of the Principal Acquisitions, 1911. London: His Majesty's Stationery Office. 1*s.*

Up to the present an occasional announcement in the press has been the only intimation received by the public of fresh objects acquired by the museum; but the Board of Education have now been fortunately inspired to follow the example of many foreign museums, and to issue an annual review of the principal acquisitions during the period. This volume is the first of the series. The descriptions of the objects are arranged according to the departments to which they respectively belong, viz., Architecture and Sculpture, Ceramics, Engraving, Illustration and Design, the Library, Metalwork, Paintings, Textiles, Woodwork, and the Indian Section. In each case the descriptions have been prepared for each department by the officer in charge of it, and a number of excellent illustrations add much value to the written accounts.

It is gratifying to learn that the list of private benefactors for 1911 is unusually long, especially as in the future, in the opinion of Sir Cecil Smith, the museum, if it is to keep pace with its requirements, will have to depend more and more on the good will of private individuals.

The book is excellently printed, and the Board of Education are to be congratulated upon their new departure.

GENERAL NOTES.

Electric Lamps for Miners.—The awards have been issued in the competition, announced by the Home Office in May, 1911, for a prize of £1,000 for the best electric lamp suitable for miners. The prize money was provided by a colliery owner, and the competition was open to persons of any nationality, conditions being laid down that the lamp must be safe, efficient, convenient, and durable, as well as economical in first cost and use. Mr. Charles Rhodes, a past President of the Institute of Mining Engineers, and Mr. Charles H. Merz, who served on the Departmental Committee on the Use of Electricity in Mines, acted as the judges. The first prize has been awarded to the C.E.A.G. lamp sent in by Mr. F. Farber, Beurhausstrasse 3, Dortmund, Germany, who will receive £600; and sums of £50 each have been apportioned to the following competitors, whose lamps are stated to "possess considerable merits":—Thomas Attwater, 22, Pelham Square, Brighton; Adolf Bohres, Zietenstrasse 12, Hanover, Germany; Bristol Electric Safety Lamp Works, 40, Great Smith Street, S.W.; The Electrical Company, Ltd., 122–124, Charing Cross Road, W.C.; W. E. Gray, 19, Archer-street, Camden Town, N.W.; H. F. Joel, 134B, Kingsland Road, N.E.; Oldham and Son, Denton, Manchester; Tudor Accumulator Company, 119, Victoria Street, S.W.

The Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held at Leeds, from September 30th to October 4th, 1912. The provisional list of papers expected to be submitted is as follows:—(1) "On Nitrogen and Iron," by J. H. Andrew (Manchester). (2) "On the Solubility of Cementite in Hardenite," by Dr. J. O. Arnold (Sheffield) and L. Aitchison (Sheffield). (3) "On the Solubility or Diffusion of Hardenite in Ferrite," by Dr. J. O. Arnold (Sheffield) and C. Chappell (Sheffield). (4) "On the Gases Evolved on Heating Steel to its Melting Point in a Vacuum," by G. Wesley Austin (Birmingham). (5) "On Allotropy in General and that of Iron in Particular," by Dr. C. Benedicks (Stockholm). (6) "On a New Type and Method of Construction of Large Gas Engines," by A. E. L. Chorlton (Manchester). (7) "On the Thermal-Magnetic Transformations of 25 per cent. Nickel Steel," by Dr. E. Colver-Glauert (Sheffield) and Dr. S. Hilpert (Charlottenburg). (8) "On a new Method for the Improvement of the Soundness of Steel Ingots by the Aid of Thermit," by Dr. Hans Goldschmidt (Essen/Ruhr). (9) "On a Method of Producing Sound Ingots," by Sir Robert A. Hadfield, F.R.S. (Sheffield). (10) "On a New Method of Revealing Segregation in Steel Ingots," by Sir Robert A. Hadfield, F.R.S. (Sheffield). (11) "On the Magnetic Properties of Manganese and Nickel Steels," by Dr. S. Hilpert (Charlottenburg) and Dr. W. Mathesius (Worcester, Mass., U.S.A.). (12) "On the Question of the Existence

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of Commercial Hyper-Eutectic White Iron Free from Manganese," by Dr. H. M. Howe (New York). (13) "On Steel Works Yields," by P. Longmuir (Sheffield) and W. H. Robinson (Sheffield). (14) "On Some Aspects of Wire Drawing," by P. Longmuir (Sheffield). (15) "On the Manufacture of Open-hearth Steel, with reference to Improvement in Yield," by F. W. Paul (Glasgow). (16) "On Rolling-Mill Practice in the United States," by J. Puppe, D. Ing. (Breslau). (17) "On the Growth of Cast Irons after Repeated Heatings, Parts V. & VI.," by Professor H. F. Rugan (New Orleans, U.S.A.). (18) "On the Iron Ores and Mineral Resources of Chili," by Charles Vattier (Santiago, Chili).

Silk Harvest in Piedmont, 1912.—This year's silk harvest in Piedmont, although slightly better than that of 1911, was still inferior to those of former years. The average production of cocoons during the last five years has been 4,757,454 kilogs (10,490,156 English lbs.) annually. Since 1908, the production of silk cocoons every year has been:—

	Weight of Cocoons.	
Year.	Kilograms.	English lbs.
1908	7,048,270	15,541,435
1909	4,040,090	8,908,398
1910	4,837,760	10,667,260
1911	3,797,080	8,372,561
1912	4,064,070	8,961,274

This enormous decrease in the annual production for the last four years must be attributed mainly to the disease of the leaf of the mulberry tree, *diapsis*, in consequence of which many landowners and farmers have been forced to discontinue the cultivation of the tree. The scarcity of the leaf, together with the present high rates of wages in the north of Italy, also have tended to discourage the rearing of silkworms in Italy generally.

Railway Construction in Tripoli.—The *Rivista tecnica delle Ferrovie Italiane* states that much activity is being displayed in railway construction just now at Tripoli. The short line along the coast to Gargaresch is to be pushed forward further west as far as Zanzur. The first section from Tripoli to Gargaresch, which has been opened already some months, is rendering good service not only for the conveyance of troops and military stores, but also for the transport of the stone required by the contractors for the harbour works at Tripoli and for the building of the walls round the town. A locomotive shed, workshops for repairs, and sidings for connecting the line with the port have also been completed. A regular service of trains has been established on the branch line, which runs in a south-easterly direction to Ain-Zara. The journey, including stoppages at the junction station at "I Fornaci" and at the cavalry barracks, occupies about three-quarters of an hour. The works of a third line running east from Tripoli to Tagiura are also in hand, and will be shortly completed.

Highest Road for Autocars in Europe.—The highest road in Europe on which a regular summer service of autocars is now running is probably the "Grande route des Alpes," which unites the shores of the Mediterranean and the Lake of Geneva. Leaving Nice, this road crosses, via Barcelonnette and Briançon, the Maritime and Alps of Dauphiné into Savoy, reaching the station of St. Michel de Maurienne at a level of 712 metres (2,338 feet) above the sea. From St. Michel, which is the frontier station at the north end of the Mont Cenis Tunnel, Chambery and Geneva can be easily reached by road or rail. The following are the altitudes of the principal mountain passes by this route:—

	Above sea-level.	
	Metres.	Feet.
Col St. Michel (Dept. Basses Alpes)	1,505	4,938
Col d'Allos	2,251	7,383
Col de Vars	2,115	6,937
Col d'Isoard	2,388	7,832
Col du Lautarat	2,058	6,750
Col du Galibier	2,658	8,718

Compared with some of the better known carriage roads in the Alps, the Col du Galibier, which divides Dauphiné from Savoy, is lower than that of the Stelvio, which is 9,155 feet above the level of the sea, and higher than the Mont Cenis (7,894 feet), the St. Gothard (6,935 feet), the Simplon (6,590 feet), or the Splugen (6,945 feet).

Price of Frozen Meat at Milan.—The present prices for frozen and chilled beef from Argentina at the cold storage warehouses of the importers at Milan, are quoted as follows:—

	Per 100 kilogs.	Per English lb.
Frozen Beef.		
Forequarters	70 to 73·50 lire	= 3·18*d.* to 3·53*d.*
Hindquarters	91 to 93·50 lire	= 4·13*d.* to 4·36*d.*
Sides	82 lire	= 3·72*d.*
Chilled Beef.		
Forequarters	93 lire	= 4·20*d.*
Hindquarters	101 lire	= 4·58*d.*
Sides	97 lire	= 4·40*d.*

Customs and town duties (*dazio*) are not included in the above prices, which are wholesale.

Manufacture of Camembert Cheese in Canada.—A French trade report states that the production of soft cheeses, especially the Camembert, is becoming an industry of considerable importance in Canada, which country may in the near future prove a formidable rival to France, especially in the American market. One factory alone at Wendover is turning out no fewer than 5,000 Camembert cheeses per day. This output, when the extensions now in progress are completed, will be tripled. The Camembert cheese made in Canada is cheap, and is much esteemed in the United States. There being no dull season in cheese-making, the dairy farmers find a constant and steady demand for the produce of their cows all the year round at remunerative prices from the cheese makers.

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Journal of the Royal Society of Arts.

No. 3,119. VOL. LX.

FRIDAY, AUGUST 30, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The examinations for next year will commence on Monday, April 7th, 1913. The full time-table was published in the *Journal* of the 16th inst.

The examinations are arranged under the following stages: — Stage I. — Elementary; Stage II. — Intermediate; Stage III. — Advanced.

The subjects include: — Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Business Training, Handwriting, Modern Languages, and Music.

In the Advanced and Intermediate Stages, First and Second-class Certificates will be granted in each subject.

In the Elementary Stage, Certificates will be given in each of the subjects enumerated. These will be of one class only.

Certificates of proficiency will be granted in each stage to Candidates who pass in certain specified subjects during a given period.

In Rudiments of Music, Higher and Elementary Certificates will be given; in Harmony, Higher, Intermediate, and Elementary Certificates.

A fee of 2*s.* 6*d.* will be required by the Society from each Candidate in each subject in the Advanced and Intermediate Stages, and in the Elementary Stage a fee of 2*s.* for one subject, and 1*s.* for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Stages II. and III.

Medals and prizes are offered in each subject in Stages II. and III.

Examinations are also held in the Practice of Music, and Viva Voce Examinations in French, German, Spanish, Portuguese, and Italian.

THE RAJPUTS IN THE HISTORY OF HINDUSTAN.

By Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

Part II.

The English in India.

In the reign of Jehanghir, 1605–27, the ever-smouldering disaffection of the Rajputs was, after a reverse suffered by the imperial troops in 1610, appeased for a time, on terms most advantageous to the Rana of Mewar, Amara II., the grandson of Udai Sing. Shah Jehan, the third son of Jehanghir, owed his succession to the throne of Delhi, 1628–58, to the support given him by the Rajputs, who in his reign were equally powerful in the court, and the camp of the Great Mo(n)gol. The year of his succession was also the year of the birth of Sivaji, the man of men destined to reanimate the Mahrattas with that Aryan passion for personal freedom and pride of race, which, under unparalleled adversities, had sustained the Rajputs through 800 years of uncompromising hostility to the rule of the Arabian, Afghan, and Mo(n)gol Mahometans. The auspices seemed favourable to the future of India—India of the Hindus; but the Mahrattas were new to the responsibilities of power; while the Rajputs in the course of their prolonged struggle for very existence with the Mahometans, had lost something of the foresight and sagacity of their once magnanimous statesmanship; and instead of uniting in a common policy toward the Mo(n)gol Empire, these inherently patriotic Hindu nationalities entered on a fratricidal contest for predominance at Delhi; with consequences that would have brought universal ruin on India, but for the tardy and reluctant, but at last definite interposition of the English in their internecine warfarings. Aurungzib,* "the

* Zib, "Ornament," occurs also in the name of his daughter, Zibanisa, "the Ornament of her Sex," the poetess

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Ornament of the Throne," otherwise known as Alumgir, "the Conqueror of the Universe," the perfidious, intolerant, fanatical, and cruel, fourth son of Shah Jehan, secured the succession to the throne by a series of the blackest and most barbarous of murders. Both Jeswunt Rao of Jodhpur and Jai Sing of Udaipur had assisted him against Sivaji; but his reimposition of the poll tax alienated the loyalty of the Rajput Princes; and his vindictive treatment of the widow and children of Jeswunt Sing drove them again into open revolt; and they were conciliated only by the remission of the tyrannous and obnoxious tax.

Under Bahadur Shah, otherwise Shah Alam I., 1707–12, the grandson of Aurungzib, the Sikhs and Mahrattas gave great trouble at Delhi; and on an alliance being formed between Rana Amira II. of Udaipur, Sivaji Jai Sing of Jaipur, and Ajit Sing [son of Jeswunt Sing of Jodhpur], virtual independence was granted to Rajputana. For the support rendered at this crisis, and in the previous rebellion against the poll tax, by Jaipur and Jodhpur to Udaipur, they had restored to their Houses the privilege of marriage with Udaipur. Unfortunately, the concession revived the antipathies excited against the former families for having given their daughters in marriage to Akbar and Humayun, and greatly aggravated the rivalries among the Rajput Princes for marriage with the pure-blooded princesses of Udaipur; the tragical issue of one of these romantic feuds directly leading at length to the establishment in 1817–18 of the British protectorate of Rajputana.

The eighth Mo(n)gol, 1712, a son of Shah Alam I., the ninth, 1712–19, and tenth and eleventh, 1719–20, all grandsons of Shah Alam I., are empty names; but the ninth, Farukshah, may be named because of his marriage, in 1713, with a daughter of Ajit Sing of Jodhpur. Muhammad Shah, the twelfth Mo(n)gol Emperor, 1720–48, was entirely in the hands of the Mahrattas, to whom he granted the *chouth*, or "one-fourth" of the revenues of the Dakkan. The Mahrattas being called in by Jagat Sing II. of Udaipur to assist him in asserting the claims of his nephew to the vacant *gadi* of Jaipur, also received for this service the *chauth* of Mewar, and the session of the District of Rampur. But the outstanding event of Muhammad Shah's reign was the invasion of India by Nadir Shah, 1738–39, with its climax in the bloody massacres of Delhi, and the symbolical abduction of "the Peacock Throne" of Shah Jehan. In the last year of his reign India was again invaded, this time by the terrible Ahmed Shah Abdalli, one of the lieutenants of Nadir Shah in 1738–39. He was met and repulsed by Muhammad Shah's son, and successor, Ahmed Shah, 1748–54. But "the Abdalli" was permitted to retain possession of the Panjab [Lahor and Multan] as a solatium for a check recognised as full of menace for the future of the Mo(n)gol Empire. Under Alamghir II., the fourteenth Emperor, 1754–59, a brother of Muhammad Shah, the dreaded Abdalli once more crossed the Indus [1756, the year of "the Black Hole"], and having seated his infant son in the government of the Panjab, marched on Delhi, and entered the city on September 11th, 1757 [the year of Plassey]. But pestilence breaking out in his army, he at once, with his prolonged lumbering trains of high-packed *loot*, marched back to Kabul.

The nominal reign of Alamghir's son, Shah Alam II., was from 1761 to 1806. As soon as "the Abdalli" was out of sight, the wirepullers at Delhi incited the Mahrattas to plunder the Panjab, and this most ill-advised, if brilliant, adventure again brought "the Abdalli" down upon Delhi. After many marchings and countermarchings, the Mahrattas were at the last driven to bay, and entrenched themselves at Panipat, there to await the onset of the Abdalli. His force was less numerous than theirs; while careful, therefore, to watch them on every side, he resolved to wait until they were starving before he destroyed them. He had not to wait long, for on the eve of January 6th (our "Twelfth Day"), 1761, Sivadasa Rao sent round the word: "The cup is full to the brimming, and we must drink it down to the dregs"; and at dawn the following day, hounded on by hunger, the whole army moved out to the attack, 65,000 horse, 15,000 foot, 200 cannon, and 200,000 Pindharis, the Chinchuses of their date. The Sindhia was on the right, the Holkar, with the Rajput auxiliaries, in the centre, and the Mahrattas from Sivaji's *svai-raj* ("Own-Kingdom," compare *svaideshi*, "Own-country") on the left. The latter, "the dalesmen" (*mavalis*) of the Western Ghats, between Poona and Sattara, drove back "the Abdalli's" right, and the Rajputs and Jats drove back his centre, and the fortune of the day would have been with the Hindu army, but that the Holkar at

Makhfi, *i.e.*, "The Anonymous"; and of Zibilina, the wife of the nephew of Kublai Khan. And in the name of the Zibu, the [*beautiful*] humped "Brahmany Bull" of India, *Bos indicus;* and of the [*striped*] "Zebra," and the Zebayer islands in the Red Sea.

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this moment treacherously abandoned the field, and was incontinently followed by the Rajputs. "The Fourth Battle of Panipat" then became the Armageddon of the Mahrattas.

The fight fought, and Delhi well looted, the Abdalli returned to Kabul, where he died, having no bonds in his death, in 1773.

At Delhi itself everything was left in confusion worse confounded than before; sometimes the Mahrattas securing possession of the person of the puppet Emperor, and sometimes the Mahometans, each in turn wielding his still controlling sceptre as the madder "Lords of Misrule."

Rajputana suffered terribly during the chaos. In Mewar the Rana Jagat Sing, 1733–51, had, as already said, surrendered Rampura, and agreed to pay half *chouth* to the Mahrattas. In the reigns of his successors, Raj Sing, 1754–61, and Arsi Sing, 1761–71, the State was constantly overrun by roving bands of these freebooters; and the Rana, Amira II., 1771–7, was compelled to yield up several districts to the Scindhia and the Holkar of the period. But it was in the early part of Bhim Sing's long reign, 1777–1828, that Mewar suffered most from the senseless and ruinous raids of these marauding Mahrattas. Jaipur and Jodhpur were treated in the like manner, but the energetic Jaipur Prince, Pratab Sing, 1769–1803, in alliance with the Jodhpur Prince, Vijaya Sing, 1752–93, succeeded in inflicting condign chastisement on them at the battle of Tonga, 1787; when Vijaya Sing obtained possession of Ajmir, after it had been held continuously from 1756 by the Mahrattas.

It was inevitable that England would be drawn into the vortex; but the pressure of the Mahrattas was first felt by the Honourable East India Company chiefly in Southern India. The complications of the position were perplexing, but Warren Hastings * was now at the head of affairs [1772, 1774–85], and at the right moment ordered Colonel Leslie to lead a force from Calcutta, diagonally across the breadth of the peninsula, upon Surat; and on Leslie's showing himself a little dilatory in his preparations for the adventure, forthwith replaced him in the command by Colonel Thomas Goddard,* who, starting off from Calcutta in October, 1778, reached Surat on February 6th, 1779. This memorable feat of combined political insight, sagacity, courage, and military skill and vigour, was vehemently denounced in England as "a frantic exploit." The reply is, that but for such heroical frenzies the English would never have been Lords Paramount of India: and the triumphant result of "Goddard's March" was the Treaty of Salbai, 1782, regulating the future relations of England with the Mahrattas, and the Nizam, and "Tipu Sahib." The prestige of the Mahrattas having been lowered by Goddard's splendid achievement, and further injured in Hindustan by the victory of the Rajputs at Tonga, they lost for a time their influence at Delhi; and Shah Alam II. passed into the hands of the Mahometan faction of the Mo(n)gol Court. Suspecting that he had amassed great treasure, the Rohilla,† Golam Kadir, to induce him to reveal the place of its concealment, put his sons [the second was Akbar II., the sixteenth Mo(n)gol Emperor, 1806–37], and grandsons [the son of Akbar II. was M. Bahadur, the seventeenth and last Mo(n)gol Emperor, 1837–57], to piteous tortures before the presence of the unhappy monarch; and this failing of its fell purpose the Rohilla Chieftain, in his fiendish rage, snatching

* See Sir John Strachey's "Hastings and the Rohilla War"; G. W. Forrest's "Selections from the Records of the Foreign Department of the Government of India," 1772–85; and Sir Charles Lawson in "The Journal of Indian Art and Industry," 1892, on his pilgrimage to the grave of Warren Hastings at Daylesford. Sir Charles Lawson's monograph is of particular interest and value, proving as it does, and all the more impressively because quite unintentionally, that the success of Warren Hastings as a public servant was based on his solid English worthiness in every relation of private life. He was the subject of the most cruel calumnies by the "little Englanders" of his day, and his memory has for nearly a century been obscured by their scandalous misrepresentations; but men like Warren Hastings always have God on their side, Who, if patient, is unerring in His law, clearly and strongly in the end discriminating between right and wrong. While, looking through Sir Charles Lawson's illustrations, one cannot help feeling that after all it is some reparation for the wrongs a man may suffer in life, to lie in death in so unpretentious and tranquil an English grave as that wherein Warren Hastings sleeps at Daylesford, the very place of his birth, and instinct with spirit of the antique benediction: "Peace be here" [Ευφημια 'στω]. In the darkest hours a statesman can know—when the beneficent results of the labours of years are suddenly exposed to destruction by party politicians, with their wild mad whirlwind of winged words, wielding the ignorant, wayward masses to their will, and he is assailed on all sides by the parasites of these demagogues, base-bred, foul-mouthed, mean fellows, Thersites-like, apt in all the vile arts of contumely and detraction,—in such hours of personal affront and insult, and evilest national portent, the tardy but complete vindication the private and public character of Warren Hastings has at length received, should reanimate faith and hope, and the sweet serenity of his sequestered grave breathe balm.

* Afterward Commander-in-Chief of the Bombay Army. Falling sick, and "invalided home," he died in sight of the Land's End, July 7th, 1783.

† The Rohillas [from *rohu*, "a mountain"] were Afghans [the Assakani—from Sanskrit *asvaka*, "horseman"—of the Greeks] who settled in and gave their name—Rohilkhand—to the country between the Jamna and the Ganges, about Bareilly, Moradabad and Bijnour up to the Tarai. They cleared these districts of their Hindu inhabitants; and their later encroachments on Oude led to the Nawab Vizier of that country seeking the protection of the English against them; which was at once given by Warren Hastings, 1781.

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the dagger from Shah Alam's girdle, gouged out both his eyes with it, casting them one after the other to the ground. The Mahrattas now regained their hold of the poor blind Emperor; and, using their opportunity to cause trouble once more in Southern India, brought on another conflict with us, 1803, "the Second Mahratta War," so called. After Wellington's victory at Assaye, September 23rd, 1803, it was most satisfactorily concluded by "the Treaty of Deogaom," of December 17th, 1803, with the Bhonsla [Mahratta ruler of the Sivaji family] of Berar, and "the Treaty of Argengaom," of December 30th, 1803, with the Sindhia; a marvellous year's work, due chiefly to the energy of the Marquis of Wellesley, as Governor-General, 1791–1805. Subsidiary treaties of protection were made with Jaipur, Jodhpur, and others of the Rajput States. These treaties were condemned "at Home" as committing England to the virtual "Protectorate of India"; and this weak, evasive demeanour of ours [that is of the Parliamentary "Opposition" of the day], before an obvious duty, disheartening the Rajputs, and encouraging the Holkar,—who, owing to the vacillations of policy caused by political cowardice of "the Home Government," had all along been left at large,—he at once fell upon Rajputana, and thus brought on "the Third Mahratta War," April, 1804, to December, 1805.

Although the Holkar caused some trouble, Lord Lake cut him up severely at Fatehghar. But the simultaneous delay in the siege of the Jat fortress of Bhurtpur emboldening the Sindhia to join the Holkar, a preposterous panic seized on the authorities at Home, who, in July, 1805, sent out Lord Cornwallis to Calcutta with express instructions to restore peace at any price. A separate "peace," in which there was no peace, was at once made with the Sindhia and the Holkar; and, although they both were absolutely in our power, the shameful and shameless price we paid for it was the sacrifice of our faithful allies in Rajputana to the unleashed vengeance of their hereditary foes. Mewar, still under Bhim Sing, was scoured from end to end by the Sindhia and Holkar, and the notorious Afghan adventurer, Amir Khan, the ancestor of the Nawabs of Tonk. The cities were destroyed, the forests burnt down, the fields laid waste, and the people driven with feline ferocity up into the unassailable and safe fastnesses of the Aravali and Satpura Hills, and Vindhya Mountains. Jaipur, under Jajat Sing II., 1803–18, was similarly devastated and desolated; and Marwar, where Man Sing's first act on the *gadi*, 1803, was to assent to the repudiation by ourselves of the treaty of protection we had solemnly entered into with his predecessor, "in articulo mortis," was left by us to the same lamentable fate. But the most abject and basest betrayal of all was of the little Rajput State of Bundi. When the British, under Colonel Monson, were retreating before Holkar, July 8th to August 31st, 1804, they at length reached Bundi, where Umed Sing, disregarding the reprisals of the Holkar, gave them a most cordial reception, rendered them every possible assistance, and conducted them safely through his kingdom, and out of all pressing danger; thus fulfilling to the letter, and in the frankest manner, the obligations we had enforced on him in 1803. Yet, and in spite of Lord Lake's protestations, we left him completely disclosured to the ruthless vindictiveness of the Holkar; for the Government in London had given their panic-stricken orders, and the abdominous and slouchy General who had surrendered New York, and made the inconclusive Treaty of 1702 with "Tipu Sahib," good slogging fighter though he was, had not the stuff in him to turn, in reply, upon the contemptible authorities in England with an accomplished fact overmastering all remonstrance or reproof.

Further serious aggravations of the troubles created by the policy initiated through Lord Cornwallis, were stayed by his transparently providential death; and when the Earl of Minto went out as Governor-General, 1807–13, the fatal consequences of our dastardly truckling to the Mahrattas were so obvious, that the exercise of the greatest discretion was required on the part of the Government of India, if order and peace were to be maintained in the country.

Then occurred the strange, sinister quarrel between Jaipur and Jodhpur for the hand of Krishna Kumari Bai, the younger daughter of the twice aforesaid Rana Bhim Sing, 1777–1828, of Udaipur. She had been betrothed to Bhim Sing of Jodhpur, 1793–1803; and on his death was claimed by his successor, Man Sing, on the specious plea that her betrothal was to the throne of Jodhpur, and not to the person in passing occupation of it. Her father, however, had already betrothed her to Jagat Sing, the effeminate and debauched Prince of Jaipur. The lovely Kumari Bai, born in 1792, was barely twelve years of age at this time; and for the next seven years Rajputana was convulsed by the rivalry of Jaipur and Jodhpur for her

innocent little hand. Nearly every Prince and Chief in Rajputana took part in the direful quarrel;—a revival in the nineteenth century A.D. of the great mythical war in the fourteenth century B.C. of the *Mahabharata;* and on its very scene. In a fatal moment both sides sought the support of the infamous Amir Khan, and his brutal banditti of renegade Mahrattas and Pindharis; who accorded it, now to the one side and now to the other, as they outbid each other for his mercenary and merciless sword. In his extremity the Rana of Udaipur besought the intervention of the English. Under the influence of the cruel orders from Home, this was refused; and, driven to despair, the miserable father yielded to the demand of the scoundrel Amir Khan to have his daughter murdered. She was now eighteen, and Greek in the grace and sweetness of her perfected loveliness; and, obedient to a fate that would, as was hoped, bring her royal House and renowned country peace — attired as a royal bride—taking the poisoned [opiate] *Kasamba* bowl, timidly proffered to her by her distracted father, and crying out gallantly :—" This is the bridegroom foredoomed for me ! "—she drank it to the last drop, falling down on the floor, in a deadly swoon, at the feet of her weeping handmaids. The heart-breaking tragedy filled India, and filled England, with horror, anguish, and remorse; and served more to convince the conscience of the people of England of the iniquity of our pusillanimous perfidy toward Rajputana, after "the Second Mahratta War," than even the representations of Lord Minto on its improvidence and folly.

It fell to the Marquis of Hastings, as seventh Governor-General, to carry out the virile policy recommended by Lord Minto; and, after settling scores with Nipal, he carried through his short and thoroughly effective campaigns of the year, October, 1817, to February 10th, 1818. They were signalised by the victories of Kirki, Nagpur, Mehedpur, Korigaum, and Ashte, involving the virtual extermination of the Pindharis; and were felicitously terminated by "the Treaty of Mandeshwar," in Rajputana, whereby a final accommodation was come to with the Mahratta States of the Dakkan, and the British Protectorate over Rajputana was reaffirmed and permanently constituted. The Holkar had to give up the whole of his ill-gotten territories in Rajputana; and the State of Bundi was liberally compensated for its disinterested loyalty to the British Raj.

"And thus in happy days, and rest, and peace," "the Fourth Mahratta War" was brought to its beneficent end.

Memories.

The fort of Asirghar, indeed, was not taken until April 9th, 1819. It crowns an isolated hill of the Satpura ["Seven-towns"] range, south of Mhow and Indor, both away on the other side of the river. I lived in the fort some two years between 1832 and 1839; and I believe I can correctly recall every prominent feature of the fortress, and of the rock on which it stands. I certainly could draw a good ground-plan of its platform, and a recognisable silhouette of its profile; and I well recollect the awe and execration with which to that day the people about me spoke of the Pindharis in the last Mahratta war. The large beaten brass *gindi* ["hollowed"], in which I tubbed, and which I took with me to England in 1839, had been an unconsidered portion of the prize booty recaptured from the Pindharis some fifteen years previously. And on every one of the six occasions on which I crossed the Nerbudda, going and returning from Mhow and Indor, or from excursions into Rajputana, there was some murderous scrimmage afoot along the rough countryside overhanging the right bank of the river; and every day *Bhils* were to be seen from afar following the jungle tracks through Khandish, when I was visiting my uncle at Dhulia; and arrows were discharged at the palanquin, or the pony, wherever I happened to be borne. This condition of things, between only seventy and eighty years ago, is now entirely forgotten, if it was ever realised by the sleek dwellers of the populous maritime cities that have grown up in India under the ægis of the British Raj—Calcutta and Madras, and Bombay and Karachi. But they remain living memories for Khandish, Malwa, Bhopal, and Rajputana; and in all the domestic histories of the reigning Rajput families, after the sickening record of the untoward calamities of the fifty-seven years, from 1761 to 1818, there is a sudden change to the joyous and frankly grateful acknowledgment made of the improvement in the material and moral condition of the country and in the position of the sovereign Princes, under the terms of the Treaty of Mandeshwar; and in every instance these histories associate the redemption of Rajputana—as of a brand plucked out of the burning—with the ever-revered name of Colonel James Tod.

Reflections.

This is the round, unvarnished recital, running through twenty centuries, from Alexander the

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Great to Muhammad ibn Kasim, and onward to Karim Khan, of the unflinching and inflexible antagonism of the high-souled Rajputs against every intruder into India, and every hateful persecutor of "the Twice-born" Hindus; a hostility inspired to the last, as from the first, by the unquenchable love of individual freedom and the unswerving, self-sustained fortitude, denotative of every true-blooded Aryan race. In all the unrivalled record of their interminable warfarings, whatever the emergency of their merciless fate, their spirit was never broken, and whatever the storm and stress of unequal battle, their rent flag was never lowered. When it could no longer be upheld, they raised the dread signal of the rallying *johur;* and shoulder to shoulder, and back to back, fought their feud out to the well and righteously purposed end of every good fight between gentlemen of "fire i' the blood."

The practical reflections suggested by the trumpet-tongued chronicle, and pressed by it as well upon us Englishmen as upon Rajputs, are:—What causes have conduced to the vitality of the Rajput passion for personal virility? and, What lessons have the results of them, as read in their history, for themselves, and, in especial, for ourselves?—not as an imperial people, for that wider scope of the question lies beyond my province here, but as individual men, living the round of our daily lives among other men. The less invidious course will be to let the reply to the first interrogation be the reply also to the second; and it is this:—The predetermining and preponderating influences in the development of the strong historical personality of the Rajputs have been the superiority of race they as Aryas share with the English and other Germans in Europe and North America; and with the French and other Latins, and the Greeks of Southern Europe; and the Russians, and the Persians; and the proper pride fostered in every man of them by the self-consciousness of their ethnical superiority; and the instinctive exclusiveness, engendered by this pride, with which they have, by vigorously avoiding mixed marriages, sought to sustain the pristine purity of their pan-Aryan strain. The distinguishing note of this superiority is virility, as shown in every worthy and beseeming quality implied thereby — temperance, endurance, patience, courage, fortitude, equity, and, above all these, because the sum of all these, magnanimity; and again, in all these natural virtues, educated to their perfected expression in the character of chivalrous men. Of such are "the brave in the dark," the darkness of forgotten history, "the heroes before Agamemnon"; and again, the innumerable English youths, beardless striplings, "steeped in honour and in discipline," who yearly yield up their lives in our army and navy, a last sacrifice to patriotism, "unwept, unhonoured, and unsung," because there is no Homer to immortalise their deeds.* Their daring is its own reward, and their one desire to find in the "enemy" they needs must meet an equal daring to their own. In Fletcher's "Bouduca," the prayer of Caratach ["Caractacus"] to the British War-God, Andate,† is:—

"Give us this day good hearts, good enemies,
Good blows o' both sides, wounds that fear, or flight,
Can claim no share in:—
Let Rome put on her best strength, and thy Britain,
This little Britain—but as great in fortune,—
Meet her as strong as she, as proud and daring."

This is the prayer of every British soldier's heart when marching into "the Field of Slaughter," and this was the prayer from the heart of every Rajput Prince when solemnly entering on a campaign against Delhi, Gwalior, or Indor, addressed to their supreme War-God, the Lord Siva, in his most eldritch sanctuary of Vindhyan Ekalinga.

This virility, the essential and fundamental element of all natural, manly virtue, has been perpetuated from father to son, through at least seventy generations, among the Rajputs, by their ancient system of domestic education. They have never confounded instruction with education, for they have never confounded knowledge with character, but have ever recognised that manual dexterities and mental acquirements, the inherent powers of the intellect itself, are vain things, unless behind them is the inspiring, guiding, controlling, co-operative, and omnificent force of a fearless, resolute, just, and benignant character, matured in the warriors of Rajputana by two thousand years of the stubbornest oppugnancy to the most heaviest malignancies of Fate; and refined

* "Qui procul hinc"—the legend's writ—
The Frontier grave is far away!
Qui ante diem periit,—
Sed Miles, sed PRO PATRIA."

† Andate, Andraste, or Andras, was a "goddess," and in Fletcher's "Bouduca" [Boudica, "Boadicea"] the word "god" is applied to her simply as the masculine of honour. The speech Fletcher puts into the mouth of "Caratach" [Caradoc, "Caractacus," ? Caird] should be compared with one of the Latin ballads of the period of the decline of the Roman Empire, sung by the Legionaries after a victory:—

"Mille, mille, decollavimus,
Unus homo mille decollavimus.
Mille vivat qui mille occidit.
Tantum vini habet nemo
Quantum fundit sanguinis."

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and elevated to a national, or rather, an ethnical ideal, by the obligation to study the history of that per-enduring argument of shed blood, imposed as a religious duty on every young Rajput of any pride in his generous race and ennobling lineage; this history being taught him, not in its dead letter of dates and statistical tables, but in its living and moving spirit as caught and handed down from man to man by the glowing genius of their tribal poet Chand Bardai. The *Mahabharata*, the *Ramayana*, and the *Prithviraj Chauhan Rasha* are the choice historical library of every Rajput gentleman; and this, simply, is why, in spite of all the calculators, the economists, and the sophisters with whom we have overflowed India, and who have for ever extinguished the epic life of Europe, "the Age of Chivalry," has not passed away in India. These poems have the same virtue in forming the historical personality of Rajputs as that exercised by the "Iliad" and "Odyssey," the plays of Shakespeare and the Bible—books that "show, contain, and nourish all the world,"—in moulding the national character of the English, as we recognise it at the very zenith of its typical and specific greatness, in the Eighteenth Century. Germany, England, and the United States of America owe everything they are, and have, to their vernacular versions of the Bible; the bed-rock of their national greatness and glory, and the sure staple, proof, and bulwark of their defence in the warfare for righteousness against "a whole world in arms"; and so long as they remain true to Luther's German rescript of the Bible, and we Anglo-Saxons to our "Authorised Version"—for both America and England that other "well of English undefiled"—it may well be asked of the three,—"Quis separabit"?

To steep and imbue the souls of men, and from childhood, in these books is indeed what alone can quicken the dead clay of mere clerical and technical proficiency into operative life, and unquestioned magistery; and of all professional experts, this baptism of the true Promethean fire, is the imperative pre-requisite of the warrior who would be a leader of warriors, of the type of—

"Henry the fift, that man made out of Fire,"

as he is finely phrased by Drayton; and, coming to our own generation, those other right heroical and illustrious Agnikulas, the Viscount Wolseley, the Earl Roberts, and the Viscount Kitchener of Khartoum. In the *Rig-Veda*, the Poet and the Warrior are one; both are Agnikulas. The hero fires the Poet, and the Poet in return rekindles the fecund flame in other heroes.* The one has no life without the other; only the poet is ever the predominant partner in their common fame. This is tersely told in Sir John Vaughan's lines [1631] "Upon the Battaile of Agincourt"—

"What *Povver* is a Poet; that can add
A life to Kings, more glorious than they had.
For what of Henry is unsung by thee,
Henry doth want of his Eternity."

To say nothing of "the Seven Arts" ["the Trivium" and Quadrivium," answering to "the Seven Planets," the three outer and four inner], which in themselves are poetry,—in the very mechanical and industrial arts the heroic spirit, which is the poetic spirit, is equally necessary, if they are to be elaborated to their paradigmal ideals. The scattered *Silpa-darpana*, "Mirrors of Art," of the Hindus, are all, so far as I have known them, written in metre, and many who have never been in India will have observed at the Earl's Court Exhibition how the Hindu weavers of carpets and other artistic fabrics, chaunted in their archaic patternings to the time of their flying shuttles, with the unfailing ascriptive refrain—*Ram! Ram!*—"Glory to God in the Highest." The whole worship of the Hindus is hymned. Anthems, Antiphons, Grayles, Introits, Proses and Sequences, all are there. And, therefore, it happens that the still living Industrial Arts of India, and the still living Chivalry of Rajputana, and the still living Religion of the Hindus—of the Mahrattas and Tamils in special—are the three only "points" on which there is any possibility of rallying and regenerating the national life of Aryan India—India of the Hindus.

"Verba Novissima."

I began by acknowledging my obligations in the preparation of this paper to James Tod and

* Simon Ockley, in his wonderful "History of the Saracens," relates how at the battle of Aignadin, July 13th, 633 A.D., wherein the Emperor Heraclius I. was defeated by Kalid, the celebrated general of the Caliphs Abubekr and Omar, the patriotic Arabian women danced behind the rear ranks of the Saracen army, as it advanced to meet the Greeks, singing: "Fight on, fight on, and we kiss you, and embrace you! Turn not back, turn not back, or we scorn and spurn you!" On the first charge of the Imperial troops the Saracens did turn back, and would have fled, but that the women rallied them with their taunts and gibes; when, refacing the Greeks, Kalid gained the victory over Heraclius. Of this character must have been the Saltatiunculæ, and Ballistea, or ballads, sung to dancing, and in the tetrametric trochaic step of the war dance of the Roman armies; and the form of these ballads thus quite naturally became that of the earliest hymns of the Christian Church Militant. In the advancing procession of the Muharram, as witnessed in Bombay, the dancing "beat" of the "Tiger-men," and other mummers, is exactly timed to the catalectic tetrametric trochaic ballad metre.

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Miss Gabrielle Festing.* She has given us all the more notable episodes of the tragic history of Rajasthan in a form that renders them generally accessible to English readers. In their strange atmosphere and outland circumstance they are fairy tales, but of the faery of real life, the direction and control of which, by a strange eventful Providence, has passed into English hands. But these stories will be profitable to us not only in familiarising us with something of the typical history and character of a magnanimous and mighty Indian people, whose future we may make or mar. They will be gainful also in stimulating in their English readers those virilities that are as instinctive in themselves as in the Rajputs. The human heart is ever animated and encouraged by the recital of tales of heroism, and Miss Gabrielle Festing's stories, "From the Land of Princes," cannot but lead those who read them to mark, learn and consider, with many close and intimate self-searchings, the clear, fixed, and unflinching view taken of life and of its inexorable necessities and stern responsibilities by the traditional Rajput gentleman; and to receive into their own bosoms some radiation from the fire and splendour of his steadfast and matchless valours. Where duty calls, the Rajput ideal gentleman knows no whimpering scruples, no debauched and impotent sentimentalities:—

"Work of his hand
He nor commends nor grieves.
Pleads for itself the Fact—
As unrelenting Nature leaves
Her every Act."

The book is sure to do good among the Rajputs also, if only by the gratification it has given them as a proof of the popular interest in their sacro-sanct country of "The Seven States" felt by us in this England of our own:—

"This royal throne of kings, this sceptred isle,
This earth of majesty, this seal of Mars,
This other Eden.
* * * * * *
This blessed spot, this Earth, this realm, this
England."

It will revive their pride in their own country and themselves, and will, I would fain hope and anticipate, lead at last to the rebuilding, in pure white marble, of Chitor, on the old ground-plan, still easily to be traced amid the ruins of the city. This would be a national Rajput achievement of the most auspicious political significance.

Of not less felicitous augury would be the dedication, by the Government of India, of the whole Kurukshetra, or "Kuru's-field," the battlefield of Staneshwara, and field of all "the Battles of Panipat," to the perpetual service of the public, as an inviolable sylvan sanctuary, on the scale and after the manner of "the National Yellowstone Park" in America; and as an Indian national park worthy at once of the imperial Delhi of the past and of the future.

Furthermore, Miss Festing's book should prepare the way for a new edition of Tod's great work, edited with the same conscientious reverence for the original text of "The Annals and Antiquities of Rajasthan," as has been shown by that eminent Orientalist, Mr. William Crooke, in his edition of Yule's "Hobson-Jobson," and by Henri Cordier in his edition of Yule's "Book of Ser Marco Polo." A reproduction of Tod's "Rajasthan," in the same loyal and worthy spirit and form, would have an immense effect in rearousing in the Rajputs a beneficent sense of their commanding place alike in the past and the future political life of India. What great publishers [it ought to be the India Office] will commission, say, Sir William Lee-Warner and Mr. W. Crooke to prepare such an edition for them, brought down to the date of the Delhi Durbar of last December? At the parting of ways whereat we stand to-day in India, its publication would do more than the "rattling" of arrows [by party publicists and politicians], the looking into the livers of sacrificial victims [Anglo-Indians], and the mixing of oil and vinegar [in the Indian Viceroys and the Indian Secretary of State's Councils], to determine the divination, whether to keep forward by the right, wreathed with olives and laurel or roses, or turn to the left, bearing the unsheathed sword to resistless slaughters. The years 1918 and 1957, in the prevision of those who know, not only the history of Hindustan, but something of the hiero-psychical temperament of Hindus, are full of the farthest-reaching fates of the future of "Sri Bharata," [the "weighty" earth whereof, and water, air and sunshine, I also took truest nativity, and pulsated into this mortal, human life some fourscore years since]; emphasised as these are by the passing, now in actual progression, of the sanctity of the Ganges to the Nerbudda:—a predication that is a simple

* An acknowledgment of my indebtedness is due also to Shri Cheda Sing Varma's "Kshatriyas and would-be Kshatriyas," Allahabad, 1894; and to Shri Purshotam Vishram Mawje's, "Shivaji's Swarajya," read before the Bombay Branch of the Royal Asiatic Society, December 19th, 1903.

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induction from an overmastering multitude of ethnographical, physiological, psychological, and historical facts; unbiased by any whisper of the "mystical lore" that comes to all men with "the sunset of life."

THE AGRICULTURAL ORGANISATION OF FRENCH EQUATORIAL AFRICA.*

French Equatorial Africa, more commonly denominated French Congo, has recently attracted a good deal of attention on account of the political treaty which has modified its area, but very few people know the real importance of its internal organisation. Therefore the study of the subject in the number of the *Bulletin of Economic and Social Intelligence* of the International Institute of Agriculture for June, 1912, will not fail to be remarked.

A first glance at the country permits of its division into three zones: a wooded coast region, the principal wealth of which consists in rubber; an inner district of steppes suitable for livestock improvement and cultivation; and finally, a desert region. About two-thirds of the part ceded to Germany is land producing rubber, the rest consists of land suitable for livestock improvement and cultivation; no portion is desert.

These regions cannot be exploited without great difficulty. There is so great a want of resources in the first-mentioned zone, that even at Brazzaville itself the market does not supply sufficient food for the population. More than in any other colony, the Europeans have to resort to preserved and other imported food. The interior produces more, but it again suffers from another drawback: its extreme distance from the coast. Finally, over an area equal to that of France, the land is burdened by the heavy mortgages of the monopolist concessionary companies. The study in the *Bulletin of Economic and Social Intelligence* deals at length with the position of these companies, but enables us to foresee the end of the concessionary *régime*. The governor of the colony himself has recently said:—

"Of eighty-one millions of immobilised hectares, nine have been restored to the Crown and to free trade, twenty-two others will be so restored within a term of ten years. This will lead more certainly towards the complete liberation of the soil, as such a movement, once begun, cannot be arrested."

The problem of native reserves is of greater delicacy, and it has been necessary to cancel the provisions of the Leopold Code, which reduced them to the area now utilised by the blacks. In fact the cultivation in use among the blacks is extensive. They burn the bush, sow and reap in the part fertilised by the ash, letting the bush then grow again and transferring their operations elsewhere. Their use is, further, to cut and gather wood in the forests or burnt over a certain area. This entire group of habits must be respected, but this will not hinder the teaching of better methods.

Another question of the day is that of labour contracts, which is the more important, as, labour being insufficient in Equatorial Africa, all the European colonies contend for it. Thence the tendency of the colonists to try to obtain contract labour, which may sometimes mean that of mere savages; while in addition to this we have the fact that labourers are often recruited by exporting companies which address circulars to the employers of labour. On the application of the colonists the labourers are sent to them on payment of a sum in advance. This is not all the profit of the "exporter"; in fact, at the end of a year, the term of the engagement, the natives are sent back to the place where they were recruited, and the payment of two-thirds of the wages promised them is made in goods by the recruiting company. One native, it is said, would receive for a year's work a supply of earthenware plates and bowls; another a supply of stuff, the greater part consisting of eyeglass cords.

It will be understood that in face of such a state of things the public authorities have been anxious to regulate the labour contract. After other measures, the imperfection of which has been recognised, a decree of April 7th, 1911, prescribes, among other things, a compulsory medical examination, with a view to prevent the engagement of too weak or too young natives, and the payment of the whole wage in money. The provisions will also be observed that relate to the return of the labourers to their homes, the attention to be given to them in their employment when ill, and the compensation they may claim for accidents in their work. The blacks of French Equatorial Africa benefit by a real system of insurance without contributions on their part, which the future will scarcely have to do more than complete.

* Summarised from the *Bulletin of Economic and Social Intelligence* of the International Institute of Agriculture, Rome. Year III., No. 6. June, 1912.

BELGIAN LACE-MAKING.

"La Dentelle Belge," by Dr. Pierre Verhaegen, provincial councillor and political and social economist, is an important work produced under the auspices of the Belgian Ministry of Industry and Public Works. It consists of nearly 300 pages of letterpress interspersed with eighty-five attractive and large illustrations, not only of typical specimens of Belgian lace—needlepoint and bobbin made —many of elaborate design, but also of Belgian lace-makers at work in their homes, at their doors in streets and country lanes, in almshouses, and in convent work-rooms.

Chapter I. treats of the past history of the industry, and will probably be found by the general reader to be the more interesting. In it Dr.

Verhaegen discusses various documents, patterns, books, and the like already known to historiographers of lace. Following the majority of them, he argues in favour of contemporaneous development of the artistic side of the art-craft in Flanders and Venice; but he considers it impossible to assign precise dates to the oldest extant specimens of lace—a task, however, which is really not of such insurmountable difficulty if one takes a broad view of the evolution, so to speak, of different methods of working threads into a pattern. For instance, the method of twisting and plaiting many threads together to form a pattern or recurrent ornamentation is common to all bobbin (pillow) lace-making, and is conclusively indicated in Assyrian bas-reliefs of potentates wearing rich costumes variously fringed and tasselled; and although it is a far cry from the Mesopotamian districts of 700 B.C. to the lagoons of Venice or the plains of Flanders in the sixteenth century A.D., there is, of course, distinct technical relationship between the make of Assyrian fringes and that of Venetian *merletti a piombini* and the Flemish *Dentelles aux fuseaux*. Again, looping a continuous thread to form an ornamental device either as an insertion into or an enrichment of linen, or independently of linen—such as Italian *reticella*—or *punti in Aria*, is a method of work the close parallel to which one finds in variegated nets made by Egypto-Romans and Copts soon after the opening of the Christian era: and looping a thread with a needle is the essential process in constructing a needlepoint lace.

The intricate ornament which can be done by twisting, plaiting, or twisting and looping fine threads together is due in the main to the influences exerted on the workpeople by peculiar circumstances of taste, the fluctuations of which can be associated with various periods. Now the conditions of culture, luxury, and intercourse were so nearly alike in Italy and Flanders in the sixteenth century, which is the time when dainty and primitive lace trimmings were first made for costumes, that both countries might have devised almost identical patterns for an insertion or a purled edging. The styles and varieties of lace then succeed one another in chronological order, some becoming identifiable with lace-making districts and thus giving rise to the adoption of local names for them. Apart from laces, pure and simple, such as those indicated above, there were early methods of embroidery which resulted in *lace-like* fabrics, and these often mislead the investigator. For example, fifteenth and even fourteenth century darning on handmade net has a *lace-like* appearance, but *quâ* method neither it nor ancient Oriental whipped and pulled thread work is technically allied with the methods of twisting, plaiting and looping threads. However, Dr. Verhaegen's synopsis of successive styles of lace is at least useful and suggestive, although one may not always agree with him in his classification of certain work. The results of his researches into the local history of Belgian lace-making are of special value, and tempt one to hope that he may pursue them with as much ardour as Mlle. Despierre displayed in collecting data for her volume on Alençon needle-made lace, published some twenty-five years ago.

Chapter II. shows where and how the Belgian industry is being pursued. The latest available statistics give a total of 47,571 lace-makers in Belgium, of whom 25,547 were in Western Flanders and 18,199 at least in Eastern Flanders.

Chapter III. is on manufacturers (*fabricants*)—under which title are included large dealers who get their stocks of lace from local agents or dealers, are sometimes employers of workers, and are both wholesale and retail distributors; other "fabricants" in a smaller way of business are themselves lace-makers, keeping shops, dealing with local lace-makers to some extent on the "truck" system, and selling to both the trade and to private customers. It is difficult, as Dr. Verhaegen remarks, to differentiate *fabricants*, *intermédiares* and *dentellières* who act as *fabricants* and *intermédiares*. Convents undertake the work of *fabricants* and *intermédiares*, and conduct the training of children and adults in the art of lace-making.

Chapter IV. is devoted to a discussion on trade, of which the foreign is the more important, and on competition as between Belgium and other countries as well as that between hand and machine-made fabrics. Under Chapter V. the different classes of *intermédiares* (distributors) are described. Chapter VI. deals similarly with grades of workers and apprenticeship. Chapter VII. treats of technical instruction as supplied through some 160 lace-making schools, the better of which are administered by conventual communities. Chapter VIII. reviews the fluctuations of the earnings of the lace-makers, and supplies interesting statistical tables setting out rates of payments under various conditions, *e.g.* for home-work done by individuals in their cottages; and for work done by groups of workers in organised work-rooms. The grinding oppression under the truck system, which luckily is not really widespread, is exposed by Dr. Verhaegen, who sums up in his last two chapters the features of the present state of the Belgian industry and of its future possibilities. Practically all that he says is germane to the industry as followed in England, Ireland and France. Amongst circumstances which have impressed themselves on him are (1) the decline of fine and elaborate lace-making by hand which is concurrent with the perfecting of methods of making lace by machinery; (2) the ignorance that prevails in the matter of lace designs for hand-work; (3) the shrinkage in various districts of the number of workers; (4) the increase in the number of centralised workrooms where groups of workers are employed under continuous supervision; (5) the number of intermediaries for buying and distributing lace—as many even as four and five stand between the *dentellières* (lace-makers) and the customer who wears the lace—a condition

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that causes frequent reclamations for improved wages.

It will thus be seen that much material has been carefully gathered together, examined, arranged and presented in a way that has been rarely adopted in regard to industries of far greater extent and importance than lace-making by hand. Dr. Verhaegen's admirable book should be most welcome to every one who is interested in the industry, whether as a manufacturer, a dealer, a weaver, or collector of its productions. Official bodies such as the county councils of Bedfordshire, Buckinghamshire, Northamptonshire and Devonshire, as well as various local committees and associations engaged in fostering the industry in this country, will find it well worth their serious study.

CORAL FISHERY IN JAPAN.

A report from the Italian Legation at Tokio gives some interesting information respecting the coral fishery in Japanese waters, and its influence on the coral industry in Italy.

Until quite recently the principal supply of the raw material was obtained by the Italian manufacturers of coral ornaments from the fisheries in the Mediterranean. These reefs, chiefly situated off the coasts of Sicily, Sardinia, Tunis, Algeria and Spain, have become practically exhausted, and Italy is now almost entirely dependent on Japan for the supply of the unworked material.

The principal market for the raw coral is Osaka, but most of the buyers, who are all Neapolitans, reside at Kobé, and resort, during the busy season in the spring and autumn, to the fishing grounds to make their purchases. Much rivalry exists amongst these buyers, which has the effect of keeping up the prices.

The import trade has also been much hampered by the increased duty now levied, amounting to 40 and 50 per cent. *ad valorem*, on coral goods entering Japan, which practically prohibits the return of the manufactured article to Japan. In fact, the value of these goods imported to Japan in 1909, which amounted to 68,640 lire (£2,745), fell the following year to 46,000 lire (£1,840), after the application of the new tariff.

The quality of the coral which is very plentiful in the seas of Japan, especially on the southern coast, varies very considerably, and is classified principally into *bello*, and *barberia*, red and white, with innumerable subdivisions, depending chiefly on grade of colour.

The quality known as *bello* is the most prized. It is worked chiefly at Naples, and at Torre del Greco, where the best class of articles are made to supply the American and principal markets of Europe. The prices vary from 15 to 30 lire per gram (about £17 to £34 per ounce avoirdupois).

The coral of the *barberia* type is in demand in certain regions in Italy, and is used principally in Romagna and the Marches for peasant jewellery.

The white coral, which is the commonest, and the red, which is subdivided into two qualities known as *mercantile* and *rosso cupo* (or dark red), is chiefly worked at Leghorn, and supplies the Indian market as well as those of Asia Minor, Russia, and Africa.

The value of coral is very variable, and depends on a variety of circumstances.

During 1911, the prices paid for the commoner sorts fluctuated between 5 lire and 600 lire per kilog (between 2*s.* and £11 per lb.), whilst the better kinds (of choice colour) realised as much as 50 lire to 5,000 lire (£1 to £100 per lb.). The production of coral in Japan varies considerably from year to year. Commencing with 1905, previous to which no statistics are available, the output was as follows :—

	Kwan.*	Yen.†	English lbs.	£ Sterling.
1905 . .	9,961	320,181	52,437	32,018
1906 . .	13,184	553,141	109,111	55,814
1907 . .	4,203	371,308	34,784	37,131
1908 . .	7,473	641,776	61,846	64,178
1909 . .	11,172	1,099,101	92,459	109,910
1910 . .	3,539	488,350	29,289	48,835

The coral fishery of Japan employs upwards of 900 boats, manned by four to five hands each. The appliances for dredging are very rude and primitive, and the fishermen have no particular skill in this branch of industry, and are engaged in ordinary fishing when not employed at this work.

None but Japanese subjects (who must first obtain a permit from the local authorities) are allowed to engage in coral fishery.

CULTIVATION OF VIOLETS AT HYÈRES.

Violets are cultivated on a large scale in many places on the French Riviera, but more particularly in the neighbourhood of Hyères and Grasse. The violets of Hyères enjoy a good reputation on account of their sweetness and beauty, and are in great demand by florists all over Europe. Large quantities of bunches of these flowers are sent away by post daily during the winter months from Hyères to most of the principal towns in the north of Europe. The violet appears to thrive well in the soil of argillaceous schist, which covers the greater part of this district; it also grows well in the alluvial lands near the rivers, and even the sandy tracts close to the sea yield good crops of this flower.

The ground for growing violets requires to be well prepared, by ploughing or digging, to a depth of 14 to 16 inches, and also to be well manured.

The beds are generally laid out in ridges and furrows, possibly running from east to west, about 2 ft. apart. The violets are planted on the northern slopes, and are sown with dwarf peas. During the winter the plants require to be sheltered from the cold north winds by a covering of mats or hurdles. These are sometimes made of

* Kwan = 8·276 English lbs. † Yen = about 2*s.* 0½*d.*

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cane or reeds, or of dry bunches of heather supported by a double row of stakes driven into the ground about 5 ft. apart. The stakes are 3 ft. high on the north side, and 5 ft. to 6 ft. on the south. These rows of sloping hurdles, which act as wind screens, are about 20 ft. apart, and do not prevent sufficient sunlight during the day from reaching the plants, or interfere with the picking of the flowers.

The violet beds last about five or six years, after which they must be ploughed up and prepared for other crops, as the ground becomes exhausted, and a period of seven to eight years is usually allowed to elapse before making a fresh plantation in the same place.

In dry weather the plants require abundant watering. The dwarf peas should be followed by salads and other crops, so as to afford partial shade to the flowers.

The principal kinds grown in this district, all of which are varieties of the common sweet violet (*viola odorata*), are the *Luxonne*, which bears a profusion of large, finely-scented flowers, of a brilliant violet colour; the *Princesse de Galles*, with an abundance of dark mauve blooms; the *Wilson*, a pale blue early flowering variety; *Le Czar*, very vigorous, with long-shaped blue flowers. Three other varieties have also been recently introduced; they are: *Madame Fichet-Nardy*, very prolific, with dark-blue flowers; *Souvenir de Madame Josse*, with fine large flowers of a reddish mauve, with white centre; *Madame Schwartz*, with large flowers of a fine violet colour.

The flowering lasts all the winter—from the beginning of November to the middle of April. The gathering is chiefly done by women and young girls, mostly Italians, who arrive in large numbers in the autumn from distant parts of Italy for the purpose, returning home as soon as the work is over in the following spring.

A good deal of skill is required for picking and making up into bunches, which contain on the average fifty-five to sixty separate flowers.

A good picker should make from 250 to 300 bunches per day, which, paid at the rate of 1.25 francs to 1.50 francs per 100, would mean from 3 francs to 4½ francs (2*s.* 6*d.* to 3*s.* 9*d.* per day). Towards the middle of March, when the flowers are very plentiful, they are gathered without the stalks, and are sold to the manufacturers of perfumes at the rate of 1.25 francs to 1.5 francs per kilogram (5½*d.* to 6¾*d.* per lb.). A large number of children are paid from 20 to 30 centimes per kilogram (1*d.* to 1½*d.* per lb.) for this work, which requires little skill.

For export the bunches of violets are carefully packed in specially made baskets of split cane or osier, 20 ins. by 12 ins. and 7½ ins. deep. They usually contain sixty-four bunches, and occasionally as many as seventy-two, carefully arranged in four layers. The baskets are first lined with oiled paper. In very cold weather, and when sent to northern countries, the baskets require a covering also of thick grey packing paper, in order to preserve their contents from the frost. The weight of these baskets, which are sent away by parcels post, does not exceed 5 kilograms (11 lbs.). The prices on the spot vary very considerably according to season, between 10 francs and 25 francs being usually paid per 100 bunches, except at Christmas and the New Year, when they fetch as much as 35 francs or even 40 francs (28*s.* to 32*s.*) per 100 bunches.

On the northern markets the prices are very uncertain, and range between 30 francs and 60 francs (16*s.* to 48*s.*).

ITALIAN TRADE WITH PANAMA.

The Italian Consul at Panama, in an exhaustive report, points out that Italy is far behind other countries—notably the United States, Great Britain, and Germany—in finding a market for their produce in that Republic.

The imports to that country, which are chiefly manufactured goods and foodstuffs, amounted in value, in 1910, to upwards of ten millions of balboas* (about two millions sterling), half of which was for goods imported from the United States (not including the value of material for the construction of the Canal), whilst the remainder was paid chiefly to Germany and Great Britain. Judging from the following list of some of the principal articles imported, it will be seen that Italy takes quite an insignificant part in the trade with Panama.

Cotton Goods.—Imported in 1910 to a total value of 847,513 balboas (£176,560), to which Italy only contributed to the value of 15,677 B., whilst the imports from the United States amounted to 236,265 B., Germany 57,468 B., and Great Britain 514,796 B.

Boots and Shoes.—Total value of imports, 517,286 B. (£107,768). Italy 495 B., United States 494,917 B., Great Britain 9,062 B.

Ready-made Clothing.—Total 498,560 B. (£103,866). Italy 7,964 B., United States 288,237 B., Germany 28,023 B., Great Britain 111,015 B.

Chemical and Pharmaceutical Products.—Total 440,931 B. (£91,860). Italy 7,599 B., Germany 28,511 B., United States 184,826 B., Great Britain 46,790 B., France 29,860 B.

Rice.—Total 334,774 B. (£69,745). Italy 375 B., Germany 205,254 B., Great Britain 110,424 B.

Woollen Goods.—Total 197,250 B. (£41,093). Italy 2,648 B., United States 5,195 B., Great Britain 179,340 B.

Condensed Milk.—Total 179,087 B. (£37,620). Italy 16,836 B., Germany 108,317 B.

Furniture.—Total 168,099 B. (£30,020). Italy 84 B., United States 136,912 B., Germany 17,617 B., Great Britain 11,062 B.

Olive Oil.—Total 126,368 B. (£26,326). Italy 8,491 B., United States 101,899 B., France 12,960 B.

Wine.—Total 108,924 B. (£22,692). Italy 5,472 B., United States (California) 22,981 B., France 51,598 B., Spain 24,532 B.

* The balboa equals 4*s.* 2*d.* English money, or about an American dollar.

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Butter.—Total 78,214 B. (£16,294). Italy 2,734 B., United States 14,207 B., Germany 26,567 B., Great Britain 20,509 B.

Straw Hats.—Total 77,440 B. (£16,133). Italy 6,065 B., United States 28,334 B., Great Britain 32,456 B.

Amongst other articles imported may be mentioned *Perfumery* to the total value of 66,450 B. (£13,844), of which Italy supplied only to the value of 671 B. *Stationery* 48,063 B. (£10,013), to which Italy 271 B. *Cheese*, total 45,022 B. (£9,384), Italy 4844 B. *Felt hats*, 37,478 B. (£7,808), Italy 2957 B. *Preserved fruit*, 28,871 B. (£6,015), Italy 819 B. *Candles*, 27,528 B. (£5,735), Italy 20 B. *Mineral water*, 22,575 B. (£4,753), 934 B. from Italy. *Parasols*, 21,892 B. (£4,560), 4,421 B. from Italy.

The total value of the exports from Panama in 1910 amounted to 1,769,330 B. (£368,602), and were as follows:—

	Tons.	Value in Balboas.
Germany	770	93,669
United States	125,321	1,508,422
France	55	1,966
Great Britain	185	165,273
	126,331	1,769,330

The exports to Italy were nil, although a profitable trade might be done in mother-of-pearl, vegetable ivory, and fancy woods with that country.

Some of the principal articles exported from Panama in 1910 were:—

	Tons.	Balboas.	£ Sterling.
Bananas (2,643,900 bunches)	114,945	921,289	191,935
India-rubber	154	170,721	35,566
Gold in bars	$2\frac{3}{4}$	134,975	28,120
Vegetable Ivory	2,105	132,635	27,632
Raw hides	565	84,864	17,680
Mother-of-pearl Shells	625	50,914	10,607

Together with tortoise-shell and live turtle, cacao, medicinal plants (sarsaparilla, ipecacuanha, copaive, etc.), mahogany, and fancy woods, etc.

FRENCH INDUSTRIES CONNECTED WITH THE CHAMPAGNE TRADE.

There are in the district of Rheims many enterprises which, while only accessory to the principal industry—that of champagne making—are quite important in themselves. Chief among these auxiliary industries is the manufacture of champagne bottles, whose production is fraught with many difficulties. The champagne bottle has to be constructed in all its parts of an almost mathematically even and heavy thickness; its glass must be perfectly smooth and unaffected by the acids contained in the wine; its neck must be exact in every particular, to insure perfect corking, and with no grain or projecting points on the inside. So much progress has been made within the last ten or fifteen years, that where formerly a breakage of 5 per cent. was considered very small, at the present time the average breakage does not exceed 1 per cent. Despite the perfection as to strength reached in the production of champagne bottles, the strain upon them caused by the pressure they sustain and the repeated handling they undergo, weakens them to such an extent that it is considered unsafe to use the bottles a second time. With the exception of smaller houses making the cheaper brands, champagne manufacturers place their wine in none but entirely new bottles. The United States Consul at Rheims says that four glass-blowing establishments in that city, of which one is among the largest in France, and several others in the vicinity of Rheims, make almost exclusively bottles for champagne. They work night and day, in three shifts of eight hours each, and turn out about 40,000,000 bottles annually. The men performing this difficult work are well paid. Another important industry entirely dependent on the wine trade is the manufacture of corks for champagne bottles. The material for these corks is principally imported from Spain, in which country is found a tree whose bark is resistent enough to permit of its use for this class of corks. The work of dressing and testing the bark, and completing the cork, is in the hands of very skilled workmen at Rheims, most of whom are well-paid Spaniards. Since it is very difficult to procure a bark thick enough to make a good cork out of a single piece, a number of the corks made nowadays are composed of two pieces of thin bark pasted together lengthwise. This process of pasting the pieces together is patented, and since the corks thus made seem to answer in every respect the demands made upon them, a number of cork manufacturers are now working under this patent, and apparently with considerable success. There are about twenty cork manufacturers in the district of Rheims, turning out annually one hundred million corks, of a value between £280,000 and £310,000. Local woodworking establishments supply the champagne houses with the boxes in which the wine is shipped to foreign countries. These are made in a mechanical way, and while they are very substantial they are of a superior finish, and afford remunerative occupation to many workmen. Several large willow-work manufacturers furnish champagne houses with the baskets in which the wine is forwarded to places in France and in near-by countries. Several firms make a speciality of the straw covers in which the bottles are encased before being packed in boxes or baskets; the straw used for these covers is cut and sewn by machinery. This industry encourages the cultivation of rye in the neighbourhood of Rheims, the straw being used for the manufacture of the covers, and the rye sold to other countries, mostly to Germany. Two firms in Rheims and four at Epernay construct special machinery for the manipulation of champagne, such as automatic bottling machines, machines for cleaning, for corking and uncorking, for wiring bottles, etc. Presses for extracting the juice from the grapes are made by several large houses in Rheims and the neighbourhood. One

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important house makes a speciality of manufacturing metallic capsules and tinfoil for champagne bottles, and numerous lithographic establishments are engaged in producing artistically decorated labels. It is safe to say that the above-mentioned industries give employment to more than 5,000 skilled workpeople. For their future prosperity much depends upon abundant harvests of grapes, the crops during the last five years having proved to be so insufficient that only several good years will prevent the champagne trade and its auxiliaries from suffering a very severe setback.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Automatic Looms.—Until a very recent date such progress as has been made with self-feeding looms in this country had been entirely in the cotton business. Even there the adoption of them has been significantly small, and it is estimated that only one loom in seventy-five in Lancashire is of the automatic type. There are about 10,000 at work in this country and about 220,000 in the United States. The contrast has been made a reproach to British manufacturers, but judgment cannot be given on the statistical appearances alone. The ring-spun American yarn is more suited than the mule-spun English to the necessities of the case. The American cloths lend themselves better to automatic weaving, and the Americans have had besides the incentives of dear and scarce labour. If Lancashire manufacturers have not adopted the loom largely they have at any rate considered its claims and advantages. The automatic loom of the self-filling and self-stopping type is now on its trial in the worsted industry, and the principal beginning has been made in a district in which weaving prices are much higher than in the surrounding area. Huddersfield, where the system of one loom one weaver obtains, has lost the trade in cheap worsted coatings to Bradford, where weavers mind two looms and work for materially lower wages at that. With the automatic machines one weaver superintends six looms in Huddersfield, and the work is so divided that the weaver gives her whole attention to the cloth; all carrying and filling of magazines is done by helpers, and all adjustments of the looms are made by men. With this aid it is hoped to win back some of the business in cheap, plain goods. The worsted looms are broad and heavy, thus differing from the cotton looms of which some weavers in America can mind twenty-six at one time. The first cost of automatic looms is two or three times that of ordinary ones, and in general more waste of yarn is generated in weaving; but it is understood that in Huddersfield practice the waste has been reduced to a minimum, and the output is some 90 per cent. of the possible efficiency. For at any rate ten years inventors of automatic looms have been knocking at the doors of worsted manufacturers, but hitherto there has been no considerable practical success with their inventions.

Profits and Turnover.—Explanations of the comparatively poor profit shown by the Calico Printers' Association will doubtless be furnished in due course. Meantime the question whether shortage of production is the responsible cause rests unsolved. In the case of any of the large concerns principally engaged in treating upon commission material the property of other persons, the fullness of the output is of vital importance to the financial result. The spinner or manufacturer may redeem a slight slackness by a fortunate transaction in his prime material. The bleacher, dyer, or printer, tied to a fixed tariff of prices, is helplessly at the mercy of the volume of work. With a production, say, of 80 per cent. of the maximum he may just hold his own; with 75 per cent. he loses an appreciable lump sum; with 90 per cent. he probably nets a large sum of money. The natural effect of narrowing profit margins is to impose a great strain upon the maintenance of output. Once the standing expenses are submerged the excess takings are virtually all profit; but much work has to be done before these more or less permanent costs are covered. Company directors do not ordinarily publish the intimate facts of their trading, but there have been admissions showing the fluctuating character of the business of calico-printing for the market. For example, there have been gains of £15,000 in one year in one works and a dead loss of money in the next. Similarly, in the dyeing trade it is known that branch works of large combines will make £20,000 to £30,000 in one year and only one-tenth as much in the next, the prices for work done being meanwhile unaffected. Of course it pays individuals to make sacrifices to get the last ounces of turnover, but the cutting of prices reacts upon prices at large and intensifies the struggle ultimately. High prices may afford some remedy, and it seems that an attempt to establish them is to be made by the Calico Printers' Association in conjunction with the leading printers outside that combine. The Association comprises nearly fifty printworks which had originally 830 printing machines, and its capital is over eight millions.

Lithographic Calico-printing.—It is reported that there is to be a considerable extension in Lancashire of the style of calico-printing now carried on at Letchworth in a comparatively small way. In this process the cloth is printed in oil colours upon what is substantially a rotary lithographic machine resembling some used in printing upon paper. Instead of the engraved copper rollers of the regular calico-printing machine, grained metal rollers are employed. The design is transferred to the surface of these from the original plate, the rollers are inked with a colour made sufficiently fatty to repel moisture, and designs in three and four colours are printed at one passage through the machine at a rate said to be eighty yards a minute. The pigments are more

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expensive than the thickened dyes ordinarily used, but the need for steaming, washing, and finishing is avoided. The process is over when the ink has dried; or at most, no more is necessary than a quick run through a cloth-mellowing machine to break up any caking of colour on the surface.

Human Hair.—The uses of human hair in making such adornments as wigs or hair-nets are better recognised than its strictly textile employments. The material is too coarse and unkind to replace wool in any of the finer services, but in conjunction with other ingredients it is used in making filter-cloths for oil-presses, and might conceivably be used in making canvas interlinings for coats. The staple article comes in the form of plaits from China, and can be seen occasionally in quantities of hundreds of bales. The hair is washed mechanically and put into the form of sliver for drawing and spinning on worsted frames. In its raw state the hair contains liberal proportions of sand.

Mill Lighting.—It is to be inferred from the publication of a factory inspection report on the subject that the internal illumination of mills is to receive more official attention. The *desiderata* laid down by the chief inspector—viz. (1) window space equal to at least one in ten of the floor space; (2) the windows to command a large sky area—admittedly cannot be met in side-lit rooms. Weaving sheds with saw-tooth roof lighting generally comply with the rate of efficiency named, but manufacture cannot economically be carried on in single-storey edifices in this country. Spinning, and the processes anterior to spinning, are conducted almost solely in rooms lit from the sides, and in these places the recommendation is to dispose the machinery in such a manner as not to obstruct the passage of daylight towards the centre of the room. The great expanse of window is the striking feature of the new standard pattern of cotton-mill, and worsted spinning mills embodying the same feature are already planned. Small pyramidal panes, intended to pass the rays of light in horizontal lines, have had to be used in some of the large side-lit mills built in America. In that country, too, much trouble has been spent by electrical engineers in devising means of soft and uniform artificial illumination and in explaining the merits of their respective systems. The matter promises to become of more moment in England, where there are still an excessively large number of mills ill-lit totally or in odd places. Darkness plays its part in creating accidents to the person as well as in impeding work, and bad lighting is a stock complaint of some of the cotton operatives' representatives in Parliament.

Collective Agreements.—Textile opinion is predominantly in favour of collective agreements between employers and workpeople in those districts in which workmen are closely organised. The mind of the cotton trade, expressed in the famous Brooklands Agreement, has been made up more than twenty years. The Bradford Dyers' Association is firmly in favour of agreements of its own which have subsisted some ten or twelve years. Newer converts, like the Huddersfield woollen manufacturers and spinners, are only anxious for powers to compel the non-associated employers to observe any arrangement into which a certain majority enter. Where all the men and all the masters are in their respective organisations the case is relatively simple. Otherwise the non-assenting parties are much in the position of those free-lances who hang upon the flanks of the Masters' Federation of Cotton-spinners and run their mills full time when the federated employers are sacrificing themselves temporarily to curtail the consumption of cotton and the gross production of yarn. There are still considerable tracts of textile manufacturing country which barely know either trade unionism or the federation of employers, and in these no question of collective bargaining arises. Again, as in the woolcombing industry, where a weak or ill-managed union has held the field, agreements have been followed by repentance and refusal to continue.

Household Novelties.—The ordinary textile manufacturer is too far engrossed in the production of goods in bulk to spare much attention to the small and sometimes lucrative articles of novelty that can be made out of suitable cloth. Such an article is the American "notion" known as the dustless duster. It proves on examination to be a square of flimsy unsized cotton muslin, made from single yarn and dyed with aniline black. The fabric in its natural condition would seem to be well suited for picking up and retaining loose dust, and this aptitude has been improved by a faint impregnation of what may possibly be a rather heavy petroleum oil. There are, doubtless, alternative means of treating muslin to make it more retentive. The commercial potentialities of a duster which neither loses its burden of dust nor requires periodical shakings at the window may be admitted, and the first cost can hardly be great. Since the invention of polishing cloths made from unfinished cotton velvet of a particular quality, there has been little to show in this direction. Silk-waste polishing cloths, resembling those used as sponge cloths for machinery, apparently do not command any extensive domestic sale, although their properties are excellent and the cloths cheap.

ARTS AND CRAFTS.

National Competition and its Future.—The exhibition of works which have gained awards in the National Competition has been open all through August at South Kensington. It will be remembered that this is said to be the last year when the National Competition under the existing regulations will be held. However that may be, and whatever changes the future may hold in store, the prevailing opinion seems to be there will almost

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certainly be an exhibition of approximately the same kind held in London next year, whether under the same or rather different designation and conditions. Undoubtedly this year's work made one feel that it would be a great loss if the exhibition were to be discontinued—though it is easy to think of minor ways in which the show might be improved. To begin with, it cries aloud for better housing. It is not merely that the approach to the iron shed in which the works have been exhibited for years past is, to say the least of it, bad; but that even when you are inside this temporary building you find yourself in a most unsuitable exhibition gallery, as unsatisfactory in its lighting as in its ventilation. Again, there is a certain proportion of work shown which makes one think that the executant has spent an amount of time on it altogether out of proportion to its real educational value—time which could, and probably would, have been employed to greater advantage had the student been intent on acquiring useful knowledge or skill rather than on gaining medals.

The really crying need, however, is for a final revision of the awards. The various subjects are very rightly and properly judged by different groups of artists, all of them competent men, many of them the foremost representatives of their own branches of art. They do their work thoroughly and conscientiously, but they are men of widely different standpoints and temperaments, and they judge leniently or hardly according to their own natural tendencies. The result is that the standard of award for different classes of work varies in some cases very considerably, and, since the same examiners go on often for quite a number of years, students get into the habit of avoiding certain subjects in which for some years no high award has been made, and crowd to certain others in which the examiners are particularly kind hearted, and are rather lavish with prizes and commendations. So it happens that certain subjects get a bad name: the best students leave them on one side, and it comes to be a generally understood thing that, say, a bronze medal is the highest possible award to be expected in that particular subject. Now, all that is very natural, and the kind of difficulty that is bound to arise. The mischief is that it is more often the designs for fairly important manufacturing processes that get hardly judged than work which, from the point of view of the nation at large, is relatively unimportant. If only after the different kinds of work had been judged by the various little groups of examiners, the judges as a whole could run through the prize works, the differences of standard would be visible to them at once, and, with a very little trouble and a reasonable amount of give and take on the part of the artists responsible, could be easily and quickly adjusted and righted. As it is, the men who have conscientiously refused to give prizes to work which they did not consider up to the mark are by no means pleased when they see students in another class getting bronze medals for work which in their class would not receive more than a commendation.

This Year's National Competition Exhibition.—One of the most cheering features of this year's exhibition is the improvement in the studies of historic ornament. Students have been understanding how to treat this subject better for some years past, but this year they seem to have realised more fully than before the purpose of studies of the kind, and to have taken pains to choose good models and to render them intelligently, showing what is really needed without undue elaboration. The set of textile studies by Louis S. M. Prince, of Manchester, was extremely good in this last respect, and there were two groups of studies of initial letters and MSS. which were excellently chosen as types. This is peculiarly satisfactory, as it tends to show that more attention is being paid to the study of historic ornament than was the case a few years ago.

Considering how important the study of plant form is to the designer, and how large a proportion of modern designs are naturalistic in character, it is rather discouraging to note that, in spite of a good many clever drawings of plants, there are very few which are treated with any idea of their suitability for subsequent use. Again, in the subject known as "Plant and three designs," while the study from nature is often quite well done, the students seem to show very little power of turning their studies to account, and the designs ostensibly based upon the drawings which accompany them too often bear little or no relation to them. It looks as though teachers were hardly aware that it is just at the point when it comes to rendering natural forms with a certain amount of convention that students generally want a little help and direction. They are apt either to think that a study from nature is practically a design, or, on the other hand, to produce a pattern in which the main characteristics of the plant are lost.

When we turn to the repeating patterns for various processes of manufacture, though there is nothing very startling, the work reaches a very creditable level of accomplishment, and the patterns as a whole are free from the disfiguring mannerisms so common a few years ago. There seems, however, a regrettable tendency to do work on a scale which is rather wanting in boldness. The wallpaper designs are decidedly poor. Whether the recommendations of the examiners, who wish to encourage the introduction of animal forms, and at the same time draw attention to the fact that students should not forget that paperhangings are intended for backgrounds, will produce better results next year remains to be seem. The designs for pottery and glass are less noteworthy than those submitted for the last few years, but the stained glass by Harry Clarke, of Dublin, to which a gold medal was awarded, was peculiarly jewel-like in colour, and shows a true appreciation of the qualities which go to make a good window. In the case of the smaller

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craftwork, one cannot help being struck by the improvement in technique which has taken place since objects of this kind first began to be included in this exhibition. The butterfly design for an enamelled silver cloak-clasp set with topaz, by Dorothy V. C. Monro, of Islington (Camden School of Art), which received a gold medal, is conceived with a good deal of imagination and carried out with skill. The wooden caskets—one to hold a presentation key, carved in French walnut by Alice L. Hitchcock, of Kensington (School of Art Woodcarving Art Classes), and the other of stained wood to hold playing cards, by Esther N. Brown, of South Marylebone (Polytechnic School of Art), which also gained gold medals, are both in their different ways very satisfactory pieces of work. The leatherwork, again, has improved greatly of recent years, though the leather book-covers are rather wanting in originality. It seems, as the examiners point out, a pity that students do not turn their attention to the designing of publishers' book-covers, for which there must be a far larger demand. Of illumination and lettering, there is a very good display. The embroidery, though it reaches a respectable level, is not particularly remarkable.

The exhibition, taken as a whole, must be looked upon as decidedly satisfactory. It displays a very creditable amount of skill and of designing power, and is far more interesting than the shows of a few years ago. The only really disturbing feature about it is the relatively large proportion of good craftwork and the comparative neglect of design for the larger manufacturing industries. This weak point seems to be recognised by the examiners and the authorities generally, and it is to be hoped it is only a phase which will soon pass away.

The Royal College of Art Exhibition.—When one crosses the road from the National Competition to the Royal College of Art, one cannot but feel that, so far as design and craftsmanship are concerned, it will be some time before the college really attains the position which it is intended to hold of a kind of university for art. It is not that the work of certain individual students is not up to the mark, but that, taken collectively, the productions fall far short of the best national competition standard. When one reflects how large a proportion of students at the Royal College are national scholars or exhibitioners, men and women who have gone through other schools in London or the provinces, and done conspicuously well there, it is rather disappointing to find that they do not turn out better, more interesting, and more individual work, when they get to the college. It is easy to understand that, at the first start, the wealth of material in the museum may prove somewhat overwhelming to the student from the provinces, that his work for a few months should really seem to go back rather than forward—but this should be merely a stage in his development, and not a permanent effect.

OBITUARY.

Clinton T. Dent, M.A., F.R.C.S.—Mr. Clinton Thomas Dent, the eminent surgeon, who had been a member of the Society since 1889, died on the 26th inst. at his house in Brook Street at the age of sixty-two. Mr. Dent was educated at Eton and at Trinity, Cambridge, and became a Fellow of the Royal College of Surgeons in 1877. He held a number of important appointments in connection with St. George's Hospital, the Royal College of Surgeons, and other medical institutions. He was also chief surgeon to the Metropolitan police. He was the author of several well-known surgical works, and contributed many articles to the medical publications.

He had a great reputation as an Alpine climber, and was a very active member of the Alpine Club, of which he was at one time president. He wrote much and well on Alpine subjects, and climbed in the Caucasus as well as in the Alps. He took a leading part in investigating the fate of Donkin and Fox, who were lost in the Caucasus in 1888. In 1897 he gave the Christmas juvenile lectures on "The Growth and Demolition of Mountains"—the scientific side of the pursuit which he had made the amusement of his life. He was very popular in a large circle of friends, to whom the announcement of his unexpected death will have come with somewhat of a shock.

GENERAL NOTES.

Mathematics and Engineering.—At the International Congress of Mathematicians, which has just held its meeting at Cambridge, Sir William H. White delivered a lecture on the place of mathematics in engineering. He said that the foundations of modern engineering had been laid on mathematical and physical science, and the practice of engineers was now governed by scientific methods applied to the analyses of experience and the results of experimental research. Notable achievements were accomplished in the last century by men whose mathematical and physical knowledge was small, but their successors enjoyed greatly superior educational advantages. The fundamental idea underlying the now accepted system of training engineers consisted in the combination of an adequate knowledge of the sciences which bore on engineering with a thorough practical training in actual works. In particular, an adequate knowledge of mathematics must be possessed by every educated engineer, because he thus acquired valuable tools by which he might overcome difficulties otherwise insuperable, as well as invaluable habits of thought. Some authorities now favoured special courses in "practical mathematics"; others believed that engineers should be taught by professional mathematicians, because this method must

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lead to broader views and greater capacity for original investigation. His experience led him to rank himself with the supporters of the latter view, and this view had now been adopted at the Imperial College of Science and Technology.

Victoria and Albert Museum.—Several acquisitions of considerable importance have recently been made in the Department of Metalwork. Among these is a small pendent reliquary in the form of a plaque, with a figure of St. Catherine in brilliant translucent enamel on silver, set in a silver-gilt frame. It is probably the work of a craftsman of Cologne in the late fourteenth century. An Elizabethan tazza is the most remarkable of recent additions to the collections of English silver. The tazza is in silver-gilt, the foot is finely *repoussé* and chased with masks and groups of fruit, the bowl is engraved with arabesque foliage, and has a raised boss in the centre which is decorated with the head of a warrior. It bears the London hall-mark for 1564-65, and the design shows the influence of the German craftsmen who were working in England during the sixteenth century. Of three examples of Continental silver, the most important is a reliquary of silver-gilt, elaborately chased. The panels on its base are decorated with foliage, and on two of them are heads which may possibly be portraits of the donors. This reliquary is a magnificent example of the best period of Spanish work in silver, the first half of the sixteenth century; and the maker's mark beneath the foot appears to connect it with the celebrated Arphe family of silversmiths. Two examples of Continental silver are a French incense-boat of the fifteenth century of graceful outline, and a silver-gilt cup and cover of about the middle of the sixteenth century. The foot of the latter bears the Strassburg mark, and it is valuable not only for its own beauty of design and workmanship, but also for comparison with English work of the period. Among other objects recently acquired, the most important is a salt-cellar of 1664, which was formerly on loan in the museum, and is well-known to collectors. It is square in plan, with an elevation somewhat in the form of an hour-glass, and has four scroll-work arms projecting from the upper surface. Plain salt-cellars of a similar type are in the possession of Winchester College, the Clothworkers' Company, and the Corporation of Portsmouth; but the example acquired by the museum is distinguished from them by its decoration of acanthus foliage which is carried out in the rich style of the Restoration period. It represents the last form of the ceremonial salt-cellar which was finally to disappear before the beginning of the eighteenth century. Two other recent acquisitions of English work may be mentioned. One is a plain two-handled cup and cover made by Richard Bayley, and bearing the London hall-mark for 1719-20. The other is a steel key with delicately chiselled and engraved barrels and wards, and a pierced bow with the crowned cipher of William III. The key is a fine example of the work for which English smiths at the end of the seventeenth century were renowned. The Department has also acquired a pair of candlesticks of silver cast and chased, which bear the Paris mark for 1714-15, and are examples of the finest work of the time. This acquisition is of special importance as the museum is not rich in French silver, although it has the advantage of the loan of a fine series from that generous benefactor to the museum, Mr. J. H. Fitzhenry. Of other examples of Continental work, the most noteworthy is a charming example of a pectoral cross in silver-gilt; it is German of the fifteenth century, and probably once contained a piece of the true cross.

Commerce of Madeira.—The report of the Italian Consul at Funchal states that the total value of the exports and imports at this port, which in 1910 amounted in value to 3,760,030 milreis* (£835,562), was only 1,890,748 milreis (£420,166) in 1911. This shows a decrease of 1,869,282 milreis (£415,396) as compared with the trade of the previous year. No reason is given for this falling-off. The principal articles imported at Funchal were coal, woven fabrics, wine, maize, corn, rice, sugar, tea, molasses, dried cod, cheese, timber for building, candles, petroleum, etc. The exports in 1910 consisted chiefly of embroidery, wine, tunny in oil, fruit and early vegetables, basket-work to the total value of 929,092 milreis (£206,465). The trade is chiefly in the hands of English and German firms established in the island. Forty sailing vessels and 983 steamers called at this port during last year; none of these were of Italian nationality.

The Refrigerating Industry in Italy.—On January 1st of the present year there were twenty-one public companies (*Società per azioni*) engaged in the refrigerating industry and registered in Italy. The share capital of eighteen of these companies established in Italy amounted to 7,045,585 lire (£281,823), and of one established at Massowa (Eritrea) with a capital of 400,000 lire (£16,000), making a total of 7,445,585 lire (£297,823). Of these twenty-one companies (the capital of two are not given), two are established at Genoa, two at Milan, and two at Naples, where the oldest company, the *Società anomima ghiacciaje e neviere napolitane*, was founded in 1885 with a share capital of 1,100,000 lire (£44,000). The company having the largest capital, viz., 1,300,000 lire (£52,000), is the *Società dei magazini refrigeranti artificiale* (Gondrand Mangilli), of Milan. There are also a large number of works for the manufacture of artificial ice in many towns in Italy carried on by private companies or owners for which no statistics are available. Refrigerating plant is also employed in breweries, cold storage, and in conjunction with other industries.

* Portuguese milreis equals about 4*s.* 5½*d.* English currency, or 4½ gold milreis equal £1 sterling.

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Journal of the Royal Society of Arts.

No. 3,120. VOL. LX.

FRIDAY, SEPTEMBER 6, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE LOOM AND SPINDLE: PAST, PRESENT AND FUTURE.*

By Luther Hooper.

Lecture I.—Delivered February 26th, 1912.

Primitive Looms: Prehistoric, Ancient, and Modern.

The spindle and the loom, the one for twisting fibre into thread and the other for weaving the thread itself into cloth, are prehistoric and almost universal tools.

These tools, and the methods of using them, have never been subject to much variation, whether invented by prehistoric man, the skilful weavers of the ancient world, or the ingenious craftsmen of the primitive tribes of to-day.

Moreover, it is not only in elementary forms of weaving that this similarity is found, for if the essential principles of the most modern spinning and weaving machinery be investigated, it will be seen that they are identical with those used in the most ancient times. The complicated textile machinery of to-day is, therefore, simply a natural development from that used by primitive weavers of all time.

In the present course of lectures my intention is to demonstrate the principles of the primitive loom and spindle, and trace their gradual development into the wonderful, but still far from perfect, mechanism of the modern machines actuated by steam power; also to indicate the lines along which textile machinery, in the future, is likely to be improved.

To-night, I shall occupy the time at my disposal by a description of primitive spinning and weaving appliances, prehistoric, ancient and modern.

Prehistoric examples of the weaver's art are extremely rare. This is owing, of course, to the perishable nature of the materials of which they are composed. Few as they are, however, and consisting, as they do, of the merest shreds of textile fabrics, they show unmistakably that the art of the loom, as well as that of the spindle and needle, was understood and successfully practised in what has been poetically called by an eloquent French writer "The night of time."

The term "prehistoric" has, of course, only a relative meaning. Roughly speaking, history begins at the period in human development when the use of metal for tools and ornaments supersedes that of stone. I believe I am right in stating that antiquities of the Age of Stone are classed as belonging to prehistoric time.

It is generally agreed that most of the Lake Dwellings of Switzerland, which were discovered and eagerly investigated during the last century, belong to the neolithic, or later stone period. It was amongst the remains of one of the earliest of these villages, discovered in the bed of the lake at Robenhausen, that bundles of raw flax fibre, fine and coarse linen threads, twisted string of various sizes, and thick ropes, as well as netted and knitted fabrics and fragments of loom-woven linen cloth, sometimes rudely embellished with needlework, were found. There were also spindle whorls and loom weights of stone and earthenware, one or two fragments of wooden wheels, which might have formed parts of thread-twisting machines, as well as rude frames which were possibly the remains of simple looms.

It is remarkable that these relics of primitive weaving were found in the lowest of three

* A large number of the illustrations are taken from Mr. Hooper's "Hand-Loom Weaving," and are reproduced by the courtesy of the publisher, Mr. John Hogg.

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villages, which, during successive ages, had been built on piles, on a common site near the margin of the lake. The linen shreds bear evidence of having been partially burned, and they were found very deeply buried in the clay which forms the bed of the lake. It has been supposed that this early village was destroyed by fire, and that to this accident we owe the preservation of the precious relics. All traces of actual textile fabrics are absent from the later villages, although loom weights and spindle whorls are found in them all.

This theory of accident may be true or not, but, however the partially-burned specimens of flaxen materials became embedded and preserved, they demonstrate that the people of the Stone Age, in Europe, cultivated flax and hemp, prepared and spun the fibres into continuous thread, doubled and twisted it into various thicknesses for different uses, and netted, knitted or wove it into fabrics of a sort which required a good deal of ingenious contrivance for their production.

Keller's work on the Lake-dwellers of Switzerland is illustrated with a large number of lithographic drawings. I have had a few of these photographed, as they show the construction of the textiles more clearly than photographs of the actual discoloured fragments of cloth and thread would do.

[Photographs of illustrations from Keller's "Lake Dwellings of Switzerland," Longman, 1892, were here thrown on the screen.]

Discoverers of such relics as these are often apt to exaggerate in their imagination the attainments of the people who produced them. Thus, Professor Messekommer, who in 1882 was fortunate enough to find the most important and, probably, earliest of the Lake-dwellers' villages, at Robenhausen, as already described, says that "he is convinced, from the specimens of textiles there found, that all manner of weaving was thoroughly known at the very beginning of the lake-building period." An expert examination of these fragments, however, does not bear out his assumption. They are, as we have seen, all webs of the very simplest kind, and are just such as are woven by savage people of to-day, by means of the most elementary weaving appliances. No traces of tools for textile work were found beyond whorls for spindles, one or two charred spindles with thread wound on them, sharp-toothed combs, which were probably used for preparing the raw fibre, and a few weights of earthenware, similar to those which were used by the Greeks and Romans for weighting the warp threads of their upright looms.

In reconstructing the life and operations of ancient and prehistoric man from the scanty relics which are available, it is most reasonable to imagine that weaving and, in fact, work of all kinds was carried on with the maximum of human craft and patience and the minimum of mechanical contrivances. We should not imagine how quickly and easily things might have been made, but how simply, even though with infinite pains, the work could have been done.

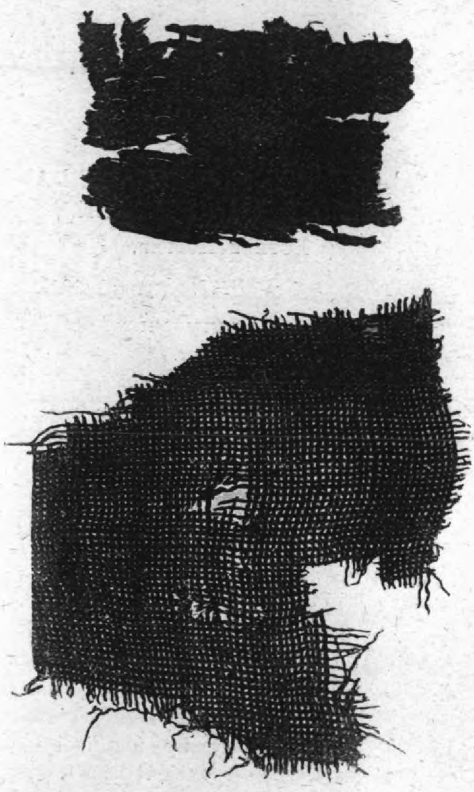

FIG. 1.—FRAGMENTS OF LINEN CLOTH, WOVEN BY THE PREHISTORIC LAKE-DWELLERS OF SWITZERLAND.

Bearing this in mind, let us examine two interesting relics of the handiwork of a prehistoric weaver shown at Fig. 1.

These are not, like so many of the fragments, netted or knitted from a single thread. This is proved by the regular and flat interlacement of its strands, which cross each other at right angles. However small the original webs may have been, a set of threads—the warp—must in each case have been stretched on some kind

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of frame. The intersecting threads—the weft —must also have been passed before and behind alternate warp threads in regular sequence. This could only have been done on a loom, however simple, and how simply a loom may be constructed let me exemplify.

Here is an oblong board, two sticks, and a piece of string.

If I wind the string on to the board (Fig. 2), and insert the two sticks between alternate cords at one end, I have made the board and sticks into a simple loom, which is typical of the loom of every country and of all time. It is typical because it has the essential characteristic of all looms, which is the crossing of the threads between the sticks. This cross transforms a collection of any number of separate strings

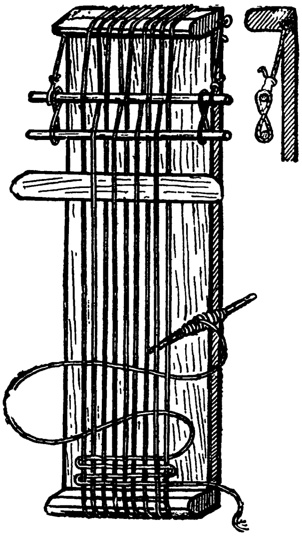

Fig. 2.—Primitive Board Loom and Shed Sticks.

into a well-ordered, weavable warp, which can easily be kept free from entanglement. In fact, without it no weaving could begin, much less be carried on to any length.

There is a roll of East African weaving in the ethnographical gallery of the British Museum. This beautiful strip of cloth is four inches wide, and is a fine specimen of modern primitive weaving. The pretty web, with its delicate pattern of checkers, could quite easily be woven on such a board as this, no other appliances being necessary than the two or three sticks, and a long, thin spindle, or needle, for inserting the weft thread.

Here is a tiny board loom, on which I have had woven a copy of one of the border stripes of the African native web. Fig. 3 (p. 950) is a photograph of it.

You will notice a number of loops hanging loosely to the unwoven threads. I need not refer to them just now, except to say that they are for the purpose of economising time and facilitating the work. Without them, the weaving would take longer, and require a little more attention, but otherwise could be as well done.

If we take a piece of loom-woven coarse canvas and examine it, we shall see clearly the stretched threads of warp and the continuous intersecting thread of weft. If a small fragment of such a piece of textile had been partially burnt, and buried in clay at the bottom of a lake for three thousand years or more, then, discovered by a fortunate archæologist, had been pressed between two glasses for preservation in a museum, it would, I think, when photographed, present very much the appearance of the shred of Lake-dwellers' linen cloth. (Fig. 1.)

I can best illustrate the method of intersecting warp and weft, on my extemporised primitive loom.

[Here the lecturer gave a demonstration of the simplest kind of weaving.]

Before proceeding to inquire into particulars regarding the form of loom used by the Lake-dwellers, it will be advisable to make a digression in order to describe the art of making thread, which naturally precedes the art of weaving.

There is no natural continuous thread except silk, all others being artificial. Silk is unwound from the cocoon of the silkworm in lengths of from five hundred to a thousand yards.

Of this thread primitive man is unaware. But he seems to have an instinct which teaches him that various vegetable and animal fibres, however short they may be, can be twisted together and joined up into threads of any required length and thickness, as well as of great strength. Weaving is well-nigh universal, but, even in the few places where it is unknown, the art of making very perfect thread and netting it into useful fabrics is commonly practised.

The process of making thread may be stated very briefly. It consists of (1) stripping and cleaning the fibres; this is called *skutching*, or ginning. (2) Of loosening and straightening out the cleansed fibres; this is termed *carding*. (3) Of drawing the carded filaments out in an even rove and twisting them together into fine or coarse continuous thread. This final process is called *spinning*.

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The arts of spinning and weaving have acted and reacted continually on one another. This was notably exemplified during the eighteenth century in this country. At the beginning of the century, weavers were often hindered by having to wait for yarn to weave, the domestic system of spinning by hand not being sufficient to keep pace with the production of cloth. This led to the invention of spinning machinery. By means of this machinery the output of yarn soon became greater than the hand-loom weavers could cope with, although there was still a growing demand for textile fabrics. The application of steam power to the loom and many improvements added to the loom itself increased the speed of weaving, and again equalised the output of the two industries.

There can be no good weaving without good spinning, for good cloth cannot be made of bad thread. Spinning can be done, slowly of course, without any mechanical aid whatever.

Here is a bundle of fibre ready for spinning. It has been simply cleaned and carded. If I draw out a few fibres and, after slightly damping them with clear water, twist them together with my fingers, you will see that they have been converted, simply by the twisting, into a strong thread. Thread thus casually made is naturally coarse and rough, but an expert spinner would make, in the same way, a fine, strong, even thread with very few fibres.

If a small stick, having a hook at one end and a weight at the other, be suspended to the spinning thread, the further even twisting of

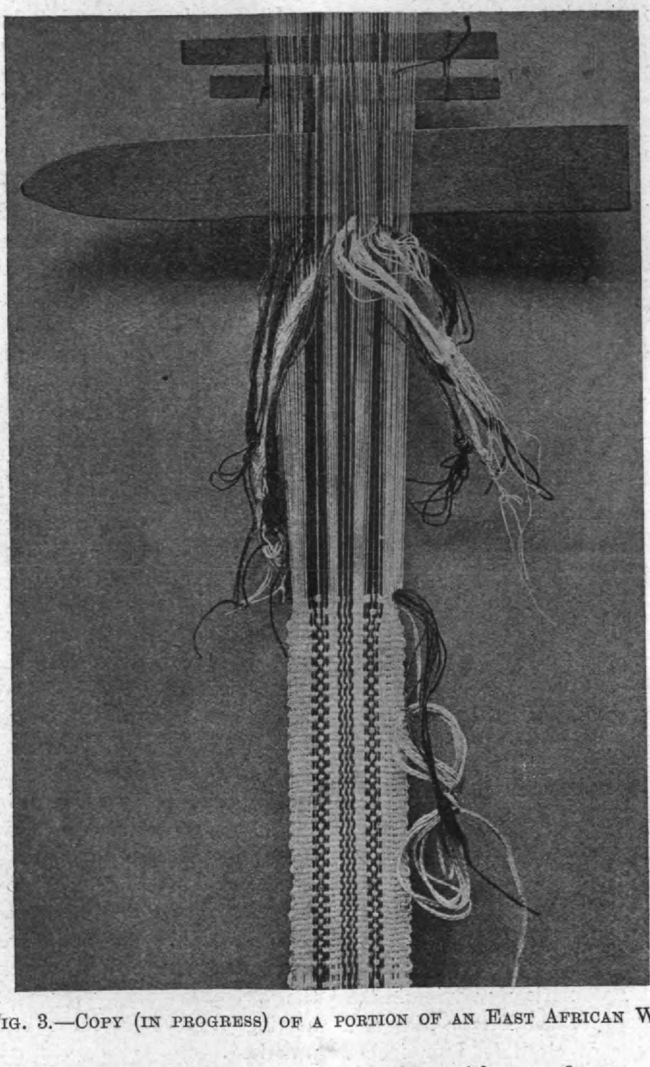

FIG. 3.—COPY (IN PROGRESS) OF A PORTION OF AN EAST AFRICAN WEB.

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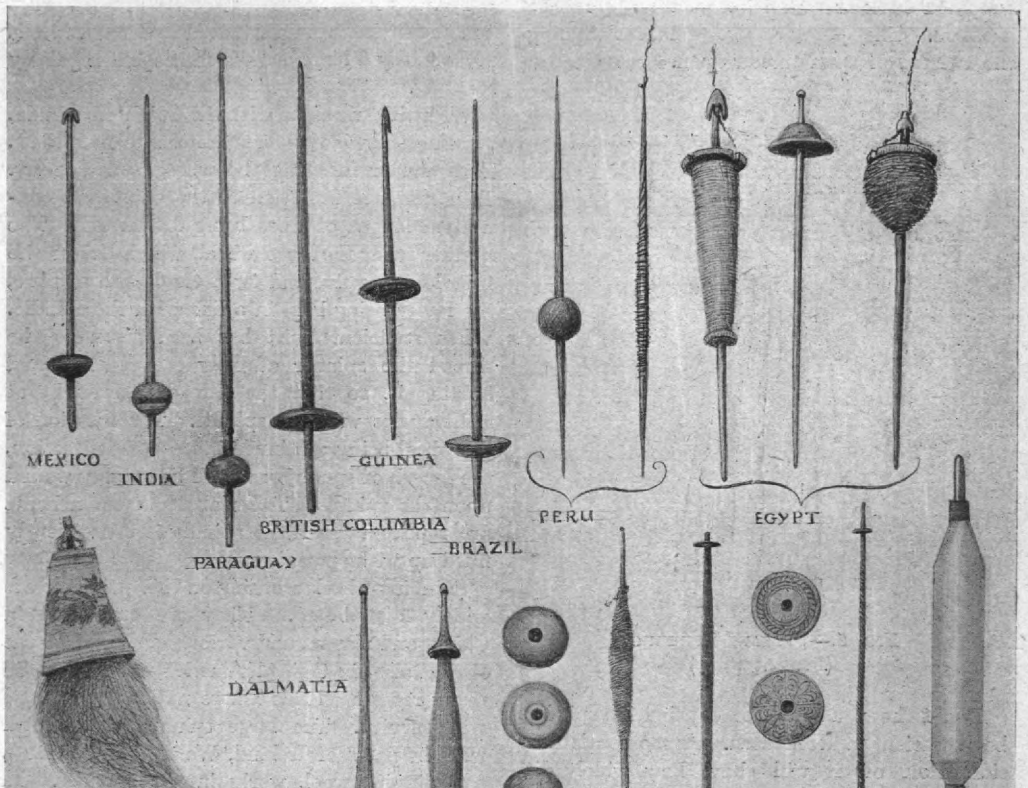

FIG. 4.—A COLLECTION OF PRIMITIVE SPINDLES, A DISTAFF, AND SOME LOOM WEIGHTS FROM VARIOUS COUNTRIES. (Drawn by the Author.)

the yarn will become much easier, because regulated by the continuous revolution of the weighted stick or *spindle*, as such an appliance is called. The spindle is also useful for winding the twisted or spun thread upon.

FIG. 5.—PEASANT SPINNING. (Present time.)

Fig. 4 shows a collection of primitive spindles both ancient and modern. A moment's consideration of it will show how widely distributed and well-nigh universal this simple industrial implement has been. One great advantage the spindle has over all other spinning appliances is that it can be carried about by the spinner without her having to discontinue her work. An ancient story by Herodotus illustrates this point.

King Darius chanced to see a Pæonian woman who was carrying a pitcher on her head, leading a horse and spinning flax. He sent spies after her, and they reported that she filled the pitcher with water, watered the horse, and returned, continuing all the while to spin with her spindle. Darius asked if all the women of Pæonia were so industrious, and being told they were ordered that all the Pæonians, men, women, and children, should be removed from their own country into Persia.

Whether this reward of merit was appreciated by the Pæonians, Herodotus does not say.

There is a painting on a Greek vase of about 500 B.C., which depicts a spinner holding the distaff in a picturesque and graceful, but unusual and, one would think, ineffective way.

Fig. 5 shows the usual method of carrying the distaff, which, it will be seen, leaves both hands of the spinner free for drawing out the fibre and twisting the spindle.

Fig. 6 is from Roth's "Natives of Sarawak," and shows the spindle attached to a small wheel, actuated by a large one which keeps it regularly rotating.

With this wheel, as with the weighted spindle, twisting and winding on are alternate operations. The manner of using the wheel is as follows. The thread is first tied to the spindle, a convenient length of fibre being drawn out. The spinner turns the large wheel, which causes the spindle to revolve and twist the length of fibre, the latter being held in a line with the spindle. When sufficient twist has been given to the thread the spinner adroitly moves the hand holding it, so that the thread is brought at right angles with the spindle. The rotation of the wheel being continued in the same direction, the length of spun thread will be quickly wound upon the spindle. These alternate movements are repeated until the spindle is conveniently filled up with spun thread.

Spinning-wheels working on this principle are widely distributed. They are still used in China and Japan, and various countries of the East; also in Central America, as well as in many remote islands where native textile arts still survive. The large spinning-wheel, still used in parts of Ireland, Wales, and Scotland, for spinning wool, works in this manner. In Scotland it is called the *muckle* wheel.

Spinning with a wheel may have been practised in Europe in ancient times, but there is no

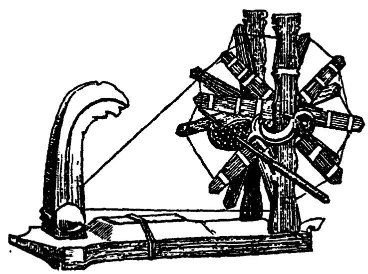

FIG. 6.—NATIVE SPINNING-WHEEL. (From Sarawak.)

evidence to prove it. The thread is the same whether spun with or without the help of a wheel. The best and finest workable thread ever produced has been spun in India by means of the spindle, at Dacca, where the famous Dacca muslins are still woven by hand from hand-spun thread.

The well-known ordinary spinning-wheel, sometimes called the Saxony, or German wheel, has

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been in use since the sixteenth century. It has an ingenious arrangement, by means of which the two operations of twisting the thread and winding it are done simultaneously. As, however, it carries the art of spinning beyond the primitive stage, I must leave its description to my next lecture.

After this rather lengthy but necessary digression, we may resume the inquiry as to the loom in its ancient and primitive form.

The presence amongst the textile relics of the Lake-dwellers of a few circular and conical shaped objects of stone and earthenware, gives a clue to the form of loom on which the prehistoric webs were woven. Such objects, pierced with holes, and sometimes elaborately ornamented, are found in excavations all over Europe. These objects are precisely like the weights which the Greeks and Romans and other ancient European peoples used for the purpose of stretching the threads of warp in their peculiarly-constructed upright looms (see Fig. 4).

Seeing, then, that similar objects to these are found amongst the Lake-dwellers' relics, it is reasonable to conclude that they were used for the same purpose, and that the form of the prehistoric loom was the same as that of the looms of a later period of which we have representations.

Amongst the vase paintings of ancient Greece only four representations of the loom are found. Two of these are rough though expressive caricatures painted on Bœotian pottery. The loom in each of these sketches is very definite,

FIG. 7.—GREEK LOOM.
(From Bœotian Vase Painting. 500 B.C.)

and, as far as it goes, evidently correct in detail. One of these painted pots is in the Bodleian Museum at Oxford, and the other, of which I have a photograph, is in the British Museum.

The subject of the painting is Kirke presenting the noxious potion to Odysseus. The loom is simply a pair of upright posts with a cross-piece joining them together at the top. Beneath the cross-piece is a roller, or beam, on which the cloth is wound as it is woven. The unwoven warp is seen hanging nearly to the ground, where it appears to terminate in two rows of circular weights. These weights keep the warp threads taut, and two sticks

FIG. 8.—PENELOPE'S LOOM.
(From Greek Vase Painting. 500 B.C.)

intersect the threads in order to retain the cross between them alternately, so keeping the warp from entanglement and preserving an opening for the passing and interlacing of the weft. In the Oxford vase, the weft is shown wound on a kind of mesh such as is used in the making of nets.

Fig. 8 is copied from a beautiful Greek vase painting. Its date is about 500 B.C. This is a much more careful and elaborate painting, but it tells little more about the loom and its arrangement. The loom is of the same simple construction, but all the parts are more carefully drawn and the pattern of the web—a highly ornamental one—is distinctly shown. There are also pegs on the top cross-piece of the loom, on which spare balls of different coloured weft are kept handy for use. Spare warp was also probably hung from them at the back of the loom.

The weights at the bottom of the loom in this case are of a conical shape, very much like those found in Switzerland. There is also, at the back of the loom, another stick or beam, which is, I believe, for the purpose of holding

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the length of unwoven warp before it passes through the holes in the weights at the bottom of the loom. The loose back threads are not shown in the painting, but the roll of cloth upon the beam indicates that more than a loom's length of warp is being manipulated. Probably the artist shirked the difficulty of representing these back threads, and so made the front ones appear to terminate at the weights.

This painting is particularly interesting, because it shows unmistakably that the elaborate pattern webs, which the classic poets so often referred to, were woven on the simplest of

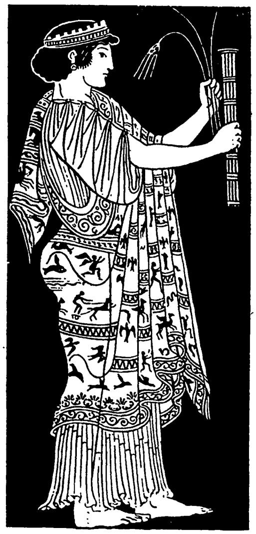

FIG. 9.—PROCESSIONAL FIGURE.
(From a Greek Vase Painting. 500 B.C.)

looms by skilful handicraft, not by means of complicated machinery, as some have supposed. In proof of this, if you will notice the border of grotesque creatures which Penelope has just woven, you will recognise its likeness to the pattern on the robe of a processional figure, copied from another vase painting of the same period, which is the subject of Fig. 9.

On a tiny vase in the British Museum there is a slight sketch of a lady weaving on a small frame, which she holds on her lap.* In this case the strings of warp are merely stretched on the frame, and there are no loom weights. There is, however, a peculiarity in the method of working depicted which unmistakably links this diminutive loom with those of Kirke and Penelope, as we shall presently see.

* Gallery of Greek and Roman Life B.M.

Olaf Olafsen, in a work on Iceland, published in Amsterdam in 1780, gives an illustration and account of a traditional loom still used, at his time, in that country. There are two or three more or less imperfect copies of Olafsen's drawing in English books, which show the striking points of resemblance this loom bears to the looms of ancient Greece.*

Looms constructed in the manner which required the kind of weights found in the Lake Dwellings, those depicted in use on the classic vases, and the traditional looms of the north of Europe, all agree in requiring a method of weaving which differs from that of all other looms the world over. This peculiarity was noticed by Herodotus, who visited Egypt about 400 B.C., and recorded his impressions. Speaking of the Egyptians, who appeared to him to do everything in a contrary manner, he says: "Other nations"—meaning, of course, Europeans—"throw the wool *upwards* in weaving, the Egyptians *downwards.*"

Now, if you will glance again at Figs. 7 and 8, after you have noted the point on the Icelandic one, you will see that the webs on these looms are all being woven from the top. This necessitates beating the weft *upwards*, as the Greek historian says, and also winding the cloth upon the top roller. In fact, the method of stretching the warp by the hanging weights, and the necessary relative position of the cross-sticks, make it impossible to weave in any other way.

The Greek lady weaving on a small frame I referred to is also shown *commencing at the top*, although in her case, the warp being stretched upon a frame, it is not necessary to weave in what we should consider an awkward way; her doing so, however, shows that it was the custom to which she was used.

The people of ancient Egypt did a large export trade with Europe, and distant parts of Africa and Arabia, in manufactured linen, the fine linen of Egypt being unrivalled in the ancient world for evenness and fineness of texture.

Owing, no doubt, to the dryness of the climate of Egypt, and the peculiar funeral customs of the Egyptians, many specimens of ancient Egyptian textiles have been preserved. Linen cloth, which was woven four or five thousand years ago or even more, may still be seen and handled, being as perfect as when it was newly cut out of the loom by the industrious Egyptian weaver.

* One of these is an illustration to the article "Tela," in Smith's "Dictionary of Greek and Roman Antiquities."

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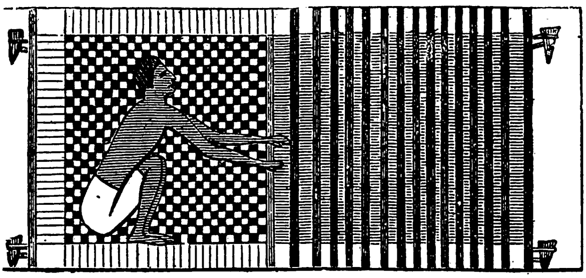

FIG. 10.—EGYPTIAN LOOM AND WEAVER.

In the British and other museums many examples of such Egyptian linen textiles may be seen. These linen cloths were unwrapped from mummies whose funerals took place under the various dynasties. As to the looms on which these textiles were woven, the few representations of them which exist show that they were constructed on a different plan from those of Europe, and bear out the statement of Herodotus that the Egyptians beat the weft downwards instead of upwards when weaving.

Only three pictures of ancient Egyptian looms are known to exist, and there seem to be no traces or fragments whatever of the looms themselves.

The drawings of Egyptian looms (Figs. 10, 11, and 12) were made from wall paintings at Bene Hasan and Thebes in Upper Egypt. Fig. 10 is rather a puzzling one, because the artist has combined a bird's-eye view of the loom with a side elevation of the weaver. The warp, which is a short one, is simply stretched upon the ground. There are no rollers or loom frame of any kind. The weaver is making a carpet or mat, it may be of rushes or grass. The only distinct facts to be gathered from this drawing are that the weft is being beaten down and the web is growing upwards; also that the warp is fixed at both top and bottom.

In Fig. 11 two weavers work at a small upright loom. The weaver to the right is inserting a stick, with a hook at the end, into the warp. This hooked stick has been the subject of much discussion, but I believe it is really a spindle with the weft wound on it, the artist not being able or not having troubled to indicate the thread. Possibly he was an ancient post impressionist, and only represented symbols and souls of things, not their actual appearance or sordid detail.

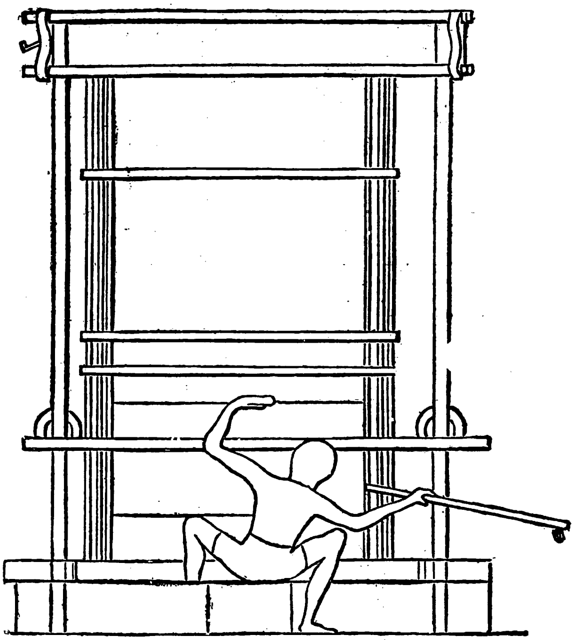

FIG. 12.—EGYPTIAN LOOM FOR LINEN WEAVING.

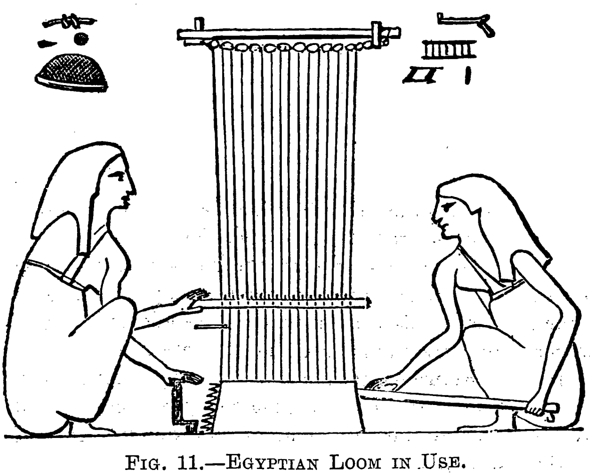

FIG. 11.—EGYPTIAN LOOM IN USE.

The weaver on the left is evidently preparing to beat the weft together with the comb which is ready to descend upon it as soon as it is inserted. Here, again, the warp is fastened at the top and bottom of the loom, and the web is growing upwards. As the loom has no rollers either at the top or bottom, only a loom's length of material can be woven on it.

Fig. 12 is a much more effective-looking loom than either of the foregoing, although there are many puzzling

points about it. It has loom posts, and is evidently a solid structure. There are no rollers definitely shown, but they may well be there. The arrangement of sticks at the top may be intended to represent a skeleton

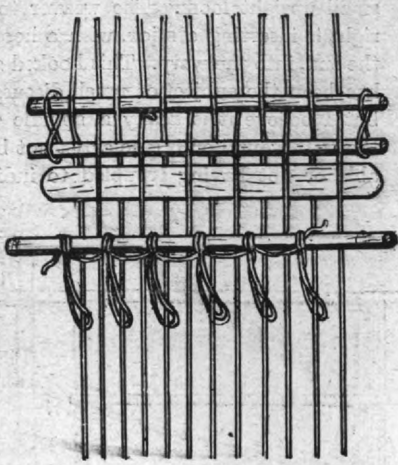

FIG. 13.—HOOPS AND HEDDLE ROD.

roller, and the bottom one on which the cloth is wound as it is made may be hidden by the bench on which the very active weaver, wielding the hooked stick, is at work. The cross-sticks

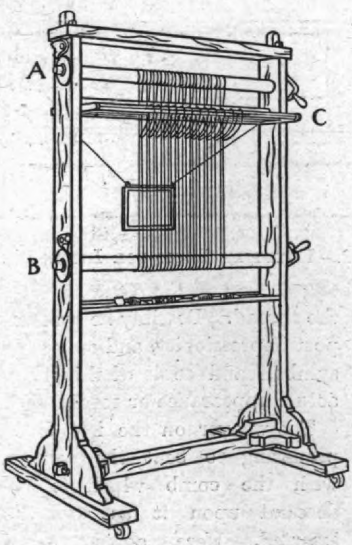

FIG. 14.—TAPESTRY LOOM.

are shown, but their purpose could never be detected from the picture. There is not much indication, only a line, as to which is woven web and which unwoven warp. I imagine the line just above the weaver's knee is that of the already woven portion, and that all above is unwoven warp. Also that the line by the weaver's left hand indicates where he is picking up alternate threads to make an opening for the weft which is wound upon the hooked stick or spindle.

Anyhow, we have here the warp stretched between the top and bottom bars, or probably rollers, of an upright loom of solid construction at which the weaver is at work in such a position that he must be beating the weft downwards, and the web be growing upwards.

Fastening the warp at both ends to rollers and weaving upwards are without doubt great advances on the ancient European methods of procedure. A further advance is the invention of what is now called the heddle rod. There is no direct evidence of this valuable

FIG. 15.—EGYPTIAN TAPESTRY.
(Cairo Museum. 2000 B.C.)

addition to the loom either in ancient Europe or in Egypt, but it is difficult to believe that the extremely fine wide linen of Egypt could have been woven, to the extent it was, without this simple and obvious appliance. Some of the finest Egyptian webs have as many as 150 threads of warp to every inch of their width, and it seems incredible that this multitude of fine threads could have been profitably manipulated with the fingers only.

It is possible that the bar across the loom (Fig. 12), on which the weaver is apparently only resting his arm, may be a heddle rod. This important appliance I must now explain.

Returning for a moment to Fig. 3, let me call your attention to the loose loops which I pointed out as time economisers, but did not further describe.

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FIG. 16.—GREEK TAPESTRY. (500 B.C.)

FIG. 17.—EGYPTO-ROMAN TAPESTRY PANEL. (Victoria and Albert Museum.)

These loose loops are attached one to each thread of the warp, which is at the back of the lower cross-stick. The cross-stick makes one shed, or opening, for the weft. The loops, on being pulled forward, bring the back threads to the front and so make the second or alternate opening.

You will see this at once if I add loops to my simple loom and insert a rod to enable me to raise them all together.

[Here the lecturer demonstrated the use of the heddle rod (Fig. 13).]

As an appliance for two important branches of textile work—tapestry weaving and the weaving of hand-knotted pile carpets—the loom, at the point we have now reached, seems to be capable of no further development.

This loom, simple as it is, cannot be improved in its mechanism, except perhaps in some unimportant details, for the use of the artist weaver to work out his free designs upon.

All the gorgeous and more or less elaborately ornamented carpets of the East, as well as the exquisitely-wrought tapestries of the West, from the most ancient times to our own, have been woven on looms of no more complicated construction than this. Added mechanical contrivances limit the scope of the craftsman. Freedom of design is trammelled in proportion to the facilities invented for the automatic repetition of pattern in the loom.

FIG. 18.—THE PERSIAN COPE. (Victoria and Albert Museum.)

Fig. 14 is a design for a small tapestry loom from Mrs. Christie's "Handbook of Embroidery and Tapestry Weaving."*

The six illustrations, with which I conclude this lecture, are taken from masterpieces of weaving made, on looms of no more elaborate construction than Fig. 14, at different periods by equally skilled craftsmen in various parts of the world.

* "Handbook of Embroidery and Tapestry Weaving," John Hogg, Paternoster Row.

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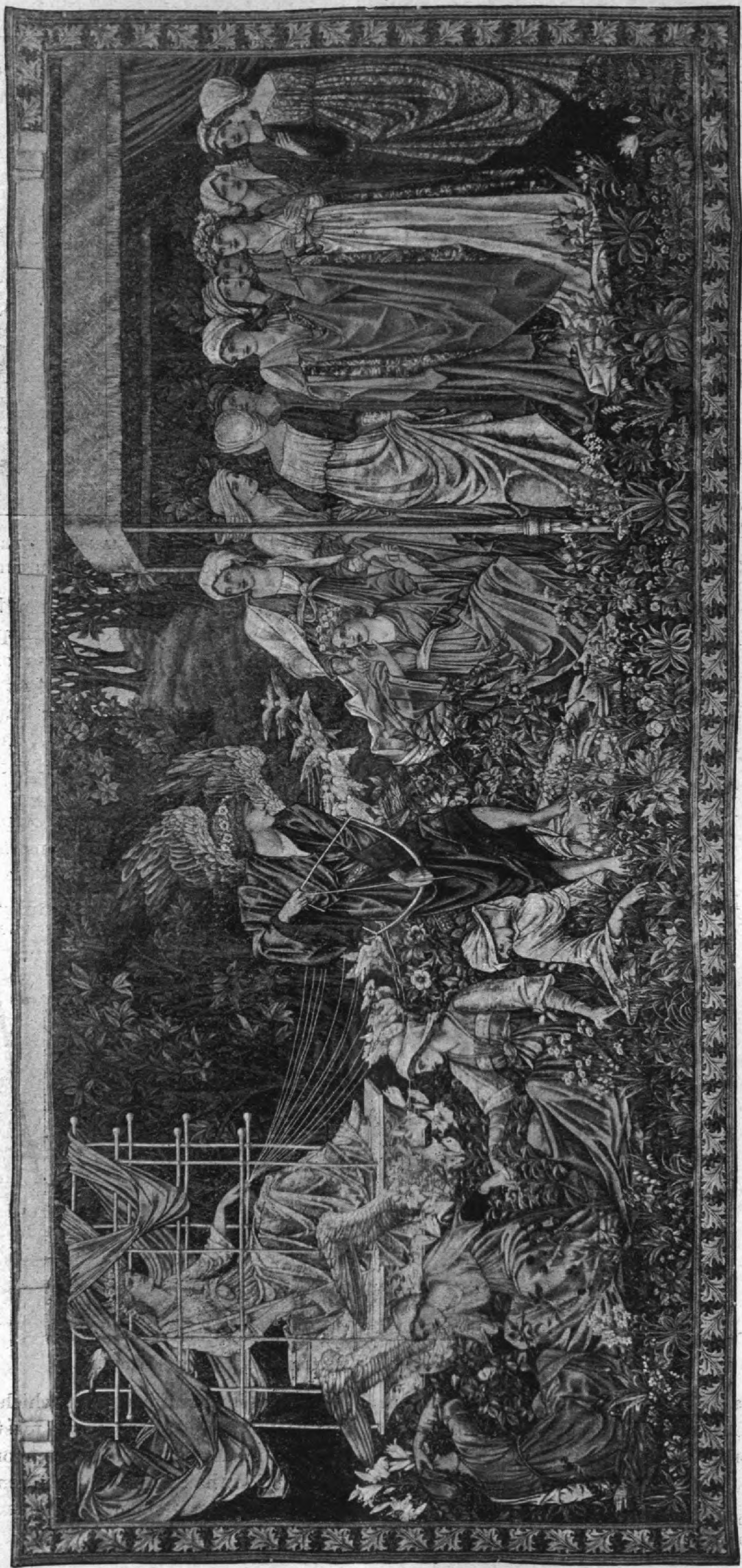

FIG. 20.—"THE PASSING OF VENUS." MORRIS TAPESTRY. (Designed by the late Sir E. Burne-Jones.)

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Fig. 15 is the most ancient piece of ornamental tapestry weaving known to exist. It is extremely fine in texture, the whole piece being only 4 ins. by $1\frac{1}{4}$ ins. in size. It formed part of the robe of Amenhilep III., who reigned in Egypt 2000 B.C. The original is in the Cairo Museum.

FIG. 19.—PORTION OF A BRUSSELS TAPESTRY. (Victoria and Albert Museum.)

Fig. 16 is a piece of Greek tapestry of about 500 B.C. It was discovered in the relics of a Greek colony in the Crimea. The original is in the Hermitage Museum, St. Petersburg.

Fig. 17 is a fine piece of Egypto-Roman tapestry, woven of coloured silk unwoven from Chinese webs. The actual size of the little panel is 4 ins. by 4 ins. It formed part of a child's tunic in the fifth century A.D.

Fig. 18 is a piece of Persian weaving of the sixteenth century. It may have been woven in Venice by Persian weavers. It is an exquisite example of hand-knotted velvet pile, there being as many as 400 knots to an inch. The colour and ornamentation are superb. It is one of the choicest treasures of the Victoria and Albert Museum collection, and is called the Persian cope.

The same museum possesses a set of Brussels tapestry of the sixteenth century. The figures are life-size, and are splendidly wrought. Fig. 19 represents a portion of one of the panels.

The subject of Fig. 20 is a modern tapestry by Morris & Co. The design, "The Passing of Venus," was made by the late Sir E. Burne-Jones. The tapestry took seven years to produce, and, being sent to the recent Brussels Exhibition, was destroyed in the disastrous fire which took place there, together with many other art treasures.

FIG. 21.—TAPESTRY WEAVING IN THE MERTON ABBEY FACTORY OF MESSRS. MORRIS & CO.

All these examples of tapestry weaving were made on such looms as Fig. 14, and are really mosaics of plain weaving with a loose weft.

Fig. 21 is a photograph of the tapestry-weaving workshop of Messrs. Morris & Co., at Merton Abbey.

Next week I shall deal with spinning machines, and the development of the loom for automatic pattern weaving.

HAIL INSURANCE IN AUSTRIA.*

The Austrian Minister of Home Affairs has recently published three reports, with intervals of only a few months between each, upon private enterprises that during the years 1907, 1908, and 1909 have transacted various branches of insurance business in the kingdoms and countries represented in the Council of the Empire. In the June number of the *Bulletin of Economic and Social Intelligence* of the International Institute of Agriculture, the most important data contained in these reports relative to one of the most useful branches of agricultural insurance, that is hail insurance, are reproduced and commented upon.

The business of hail insurance is transacted in

* Summarised from the *Bulletin of Economic and Social Intelligence* of the International Institute of Agriculture, Rome. Year III., No. 6. June, 1912.

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Austria only by national and Hungarian institutes, seventeen in all. Taking account of their form of organisation, they may be divided into four national societies limited by shares, ten mutual institutes (seven large mutual institutes and three local societies), and three Hungarian societies limited by shares. The extension of the operations of the insurance institutes working in the territory of the Empire is examined in the above-mentioned study from three points of view: (a) the number of policies and the amounts insured; (b) the amount of premiums collected; (c) the amount of claims paid. From the statistical tables we see that hail insurance tends to spread more and more among the farmers of the Empire, although when we consider a long series of years we see that the increases in the number of policies and in the amount insured are somewhat inconstant and irregular. This depends on the irregularity of the risk of hail itself; sometimes long periods pass without any devastating hailstorm to be reported, and the farmers, trusting in the continuance of this, are indisposed to insure.

The country in which insurance institutes are most numerous is Bohemia, where there are fifteen societies working (exclusive of three local societies). Next comes Moravia with twelve societies; on the other hand, there is only one society working in the Littoral and two in Carinthia. In Dalmatia and in Tyrol, including Vorarlberg, no insurance business was done.

In the case of every region of the Empire data are given as to the amount insured, the average amount insured for each contract, and the amount of the average premium as percentage of the amount insured. Thus, examining the first group of data, the reader may form an idea on the development of insurance in the separate territories; the data as to the average sum per policy are of considerable interest as indications of the distribution of large and small property; finally, the amount of the average premium shows how the risk of damage from hail is generally estimated by the insurance societies in the various regions of the Empire.

Thus, for example, the average value insured per policy in six Austrian mutual institutes varies between 1,266 and 2,685 crowns, while, on the other hand, the average amount insured in the mutual institute of Cracow is 7,663 crowns. This appreciable difference is explained by the economic and social conditions of Galicia; the small landowners insure to a relatively smaller degree in this country than in other territories of the Empire.

In the statistical tables showing the premiums collected in recent years, we see that these premiums tend to increase, probably in consequence of the heavy hailstorms, that have lately been more frequent and more violent.

We observe, finally, that also in Austria the societies limited by shares are the institutes that extend their business most widely; it is enough to say that of four such societies, two were working in eleven regions and one in ten, while of the seven mutual societies only one was working in six regions, four limited their operations to three regions, one to two and one to a single region. And while all the societies limited by shares extend their operations beyond the limits of the Empire (all of them work in the countries under the Hungarian Crown and one also in Italy), on the other hand, the direct insurance business of the mutual institutes is limited to the regions of the Empire.

Generally, however, there is useful competition between the two forms of organisations.

MAP OF THE WORLD.*

I would like to allude to a very important geographical undertaking which has made considerable progress during the past year. This is the production of the international Map of the World on the scale of $\frac{1}{1000000}$, a project which has been under the consideration of the leading geographers of the important countries for more than twenty years, since it was first proposed at the International Geographical Congress held at Berne in 1891. The question was discussed at succeeding Geographical Congresses, but did not take definite shape until the meeting held at Geneva in 1908, when a series of resolutions dealing with the subject were drawn up by a committee composed of distinguished men of many nations, which was appointed to formulate rules for the production of the maps, so as to ensure that they should be prepared upon a uniform system.

These resolutions were approved at a general meeting of the Geneva Congress, and were forwarded by the Swiss Government to the British Government for consideration, whereupon the latter issued invitations to the Governments of Austria-Hungary, France, Germany, Japan, Russia, Italy, Spain, and the United States of North America, asking them to nominate delegates to act as the members of an International Committee to meet in London and debate the question. This committee assembled at the Foreign Office in November 1909, and Colonel S. C. N. Grant, C.M.G., then Director-General of the British Ordnance Survey, was appointed President. The proceedings were opened by the Under-Secretary of State for Foreign Affairs, Sir Charles Hardinge, G.C.M.G., now Lord Hardinge, who, in his address, referred to the progress that had already been made with regard to the international map, and expressed the hope, on behalf of the British Government, that the great undertaking might be brought to a satisfactory conclusion.

The main business before the committee was to settle on the mode of execution of the map, especially as regards the size of the sheets, so as to

* Extracted from the Presidential Address to the Geographical Section of the British Association, by Colonel Sir C. M. Watson, K.C.M.G., C.B.

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ensure that adjacent sheets, published by different countries, should fit together; and also to settle upon the symbols, printing, and conventional signs to be used, in order that these should be uniform throughout. A series of resolutions, embodying the decisions arrived at concerning these various points, was approved and drawn up in English, French, and German, the first of these languages being taken as the authoritative text. As the map was to embrace the whole surface of the globe, the method of projection to be adopted was, of course, a very important consideration, and, after due deliberation, it was decided that a modified polyconic projection, with the meridians shown as straight lines, and with each sheet plotted independently on its central meridian, would prove the most satisfactory.

The surface of the sphere was divided into zones, each containing four degrees of latitude, commencing at the equator, and extending to 88° North and 88° South latitude. There were thus twenty-four zones on each side of the equator, and these were distinguished by the letters A to V north, and A to V south. This fixed the height of each sheet. For the width of the sheets, the surface of the sphere was divided into sixty segments, each containing six degrees of longitude, and numbered consecutively from one to sixty, commencing at longitude 180°. This arrangement made each sheet contain six degrees of longitude by four degrees of latitude; but as the width of the sheets diminished as they approached the poles, it was decided that, beyond 60° North, or 60° South, two or more sheets could be combined. Each sheet could thus be given a clear identification number defining its position on the surface of the globe, without it being necessary to mention the country included in it, or the latitude and longitude. For example, the sheet containing the central part of England is called North, N. 30.

In order to ensure that the execution of all the maps should be identical, a scheme of lettering and of conventional topographical signs was drawn up and attached to the resolutions; and it was decided that a scale of kilometres should be shown on each sheet, and also a scale of the national measure of length of the country concerned. As regards the representations of altitude, it was arranged that contours should be shown at vertical intervals of a hundred metres, or at smaller intervals in the case of very flat, and larger in the case of steep ground, the height being measured from mean sea-level, as determined in the case of each country; while the levels of the surface of the country were to be indicated by a scale of colour tints, the colours being green from 0 to 300 metres, brown from 300 to 2,500 metres, and purple above 2,500 metres. In the same manner the depths of the ocean and of large lakes were to be indicated by varying tints of blue, so as to show intervals of 100 metres. In order to ensure uniformity in the scale of colours to be used, a copy of it, as approved by the committee, was included in the plate of topographical symbols.

The whole scheme was thoroughly well worked out, and great credit is due to the members of the International Committee for the manner in which they carried out their difficult task. Since the meeting of the committee in 1909 the preparation of the sheets in accordance with the principles decided upon, has been taken in hand in several countries, and a number of these have been issued which give a good idea of what this great map—the largest ever contemplated—will be like. These sheets deserve to be carefully studied, and will doubtless be the subject of considerable criticism, as there are several points which seem worthy of examination.

CHINESE BLACKWOOD FURNITURE.

A characteristic product of China known all the world over, and admired in varying degrees by foreigners generally, is Chinese blackwood furniture, including cabinets, chairs, stools, pedestals, centre and side tables, frames, and articles for the drawing-room, elaborately carved and decorated, and manufactured or supposed to be made from a blackwood. This furniture, if real in all respects, is produced from various dark woods, generally from *Dalbergia lotifolia*, or hard, heavy, close-grained, dark red wood, known to the Chinese as "ka-hee" or "furniture wood," or sometimes as "sun-gee" or "dark red wood." When exposed to the air for a long time this wood turns dark and eventually becomes black, with more or less red streaks in the grain corresponding to the amount of resinous or other colouring matter in the grain. Originally the Chinese used this wood for their own fine furniture and for wood bases, or frames for porcelains, jade carvings, or other ornaments for display in drawing-rooms. Chinese furniture ordinarily is quite plain, generally constructed in long curves or rounded corners, straight backs to the chairs, settees with straight backs, often set with porcelain or marble panels, and similar pieces, while bases for porcelain or other similar work were often beautifully carved. With the advent of foreigners in South China, however, there came a demand for a combination of furniture more or less on the Chinese model, which was carved instead of plain. The Chinese manufacturers eventually designed furniture somewhat on foreign models with the popular elaborate carved ornamentation, the local demand for which spread into a world-wide trade. According to the American Consul-General in Hong-Kong, the actual volume of this trade is not large, the United States probably taking more of it than any other nation. Formerly most of this furniture was made in Canton, which still annually sends £9,000 worth, practically all to Hong-Kong, besides a considerable quantity shipped abroad as household furniture. In Canton, a district practically given over to the manufacture of such furniture is a point of interest for tourists. Of late years these factories have sprung up in Hong-Kong, where most of the product is actually

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sold to users, and there are now eight such establishments. A few years ago there was a good deal of fraud in the business, and soft light woods stained black were used, just as most of the so-called cherrywood furniture in Japan is now soft white wood stained cherry before finishing. The use of poor wood so injured the trade that the Chinese guild concerned decided to use only the real blackwood, and this in Hong-Kong is characteristic of the trade, though, of course, there is still need to guard against inferior woods. Practically all the hard wood furniture is hand-made. Furniture is planned in parts, which generally dovetail together in order to eliminate screws or nails, and the various parts are shaped for the carver. The latter sits on the earth floor and works with various knives, chisels, and other tools of native workmanship, but with no other bench than that afforded by his legs, toes, and the earth floor, or in exceptional cases, a log combination of seat and bench. Workmen in these shops are practically bred to the business. An apprentice serves three years with no other pay than his rice. He then earns about one sovereign per month. An experienced carver will ordinarily receive two pounds per month. When carved the article is usually stained a uniform black by an alum preparation, then waxed with a preparation of wood oil and blacking, and polished, or sometimes finished with a special preparation of Ningpo varnish. Foreign oils and varnish are sometimes used for special purposes, but as a rule only native materials are employed. The popularity of Chinese blackwood furniture seems on the whole to be increasing, and a strong demand is growing for furniture manufactured from this wood on plainer lines, and to some extent for settees and chairs in Chinese styles.

ENGINEERING NOTES.

Centenary of Krupp's.—The centenary, or rather the first year of the second century, of the well-known steel works in Germany has just been celebrated with great pomp and circumstance. We are accustomed to regard the German establishments of which Krupp's stands first as keen modern rivals of a large number of our engineering industries; but with Krupp's this began so far back as November 1811, when Friedrich Krupp opened a small manufactory in Altenessen, not only to compete with English supplies of cast steel, but to supply the place of importations from Great Britain, which had been blocked by the strategy of Napoleon. It was a very small factory and was worked by water-power, and, to show the great advance that had been made between then and now, we find that the population of the town at that time was 4,000, and now, through the influence of the Krupp works, it amounts to 300,000. At first, however, there was a great struggle, and Friedrich Krupp died in 1826 broken-hearted by failure. It was his son, Alfred, who was born in 1812 and lived till 1887, who created the business that now spreads over the whole world, and he might be rightly called "the Father of the Steel Industry." There were only four men employed at the works when the elder Krupp died, whereas in 1873 the number had reached 16,000, and when Alfred died there were 20,000. Now, in 1912, there are 36,000 men at the steel works alone, beside 32,000 in the employment of the firm on works in connection with the business at Essen and elsewhere. At the London Exhibition of 1851 the British manufacturers were astonished to see exhibited by Krupp's a steel block of no less than 4,500 lbs. weight. This was three years after the works had been sold by the family to Alfred Krupp for £5,000. Up to the sixties, purely cast steel products were the business of the works; but since then nearly every branch of engineering material has been turned out, more especially rifle barrels and cast-steel guns, which had begun to supersede bronze. In 1867, he introduced hooped and jacketed guns, and two years later gun-mountings. In the early eighties the business was turned into a company. Armour plating for ships and steel rails, which had begun to displace iron, gave the firm further opportunities; so that now the works which had been managed by Friedrich Alfred Krupp, Alfred's son, who died in 1902, comprise, besides the Essen establishment, three collieries, many mines, a wharf at Rotterdam, and the Germania shipyards at Kiel. At present the head of the firm is the Baroness Krupp von Bohlen-Holbach, the great-granddaughter of Friedrich, who is married to the Baron of that name, and was authorised to continue the family name in her new title.

Electric Furnace for Non-ferrous Metals.—The Pittsburg Electric Furnace Company, of Pittsburg, Pennsylvania, have recently installed furnaces for melting brass, drosses, scrap metals, and other non-ferrous metals and alloys. The inventor of the process used at Pittsburg is R. T. Wile, the manager of the works. The current of electricity used may be either direct or alternate, and the furnaces stationary or tilting. The stationary furnaces have up to 20 tons capacity, and the tilting ones vary up to 1,000 lbs. a charge. A furnace melting a charge of 200 lbs. of brass consumes 22 kilowatts at a hundred volts, 500 lbs. require 32 kilowatts, and 1,000 lbs. 68 kilowatts.

Internal-combustion Locomotives. — Necessity is the mother of numerous children besides invention, one being the adaption of invention. The Trans-Australian Railway, the construction of which is now in hand, will run through 1,060 miles of the Commonwealth, most of which is practically waterless country, for the little rain that falls is lost by percolation through the limestone formation of which the country is composed. Owing to this fact, and that the steam engine was the only method of traction in view when the estimates were made, no less a sum than £609,000 was

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estimated for providing water for the locomotives. The internal-combustion locomotive has, therefore, been thought of as a means of getting over the difficulty; but there has been no example so far of this machine on long-distance lines. On the Great Central Railway there has been recently put into service a Westinghouse internal-combustion coach, having a 90 horse-power six-cylinder petrol engine, driving a 55-kw. dynamo, which in turn supplies power to two electric motors. This vehicle is stated to be capable of a speed of forty miles an hour on the level, to weigh twenty-five tons, and to have seating capacity for fifty passengers. Petrol-electric coaches of this character are said to be running on the Hungarian railways at half the running cost of steam motor coaches, and there have been numerous gasoline motor coaches for a considerable time in service in America. Internal-combustion engines have also been tried on the South African railways. It may be explained to readers who are not familiar with the difference between steam locomotives and those of which we are speaking, that instead of steam from the boiler being forced into the cylinders, a mixture of air and gasoline vapour is sucked into the cylinders by the piston. It is true the power cannot be efficiently obtained until this mixture is, to a greater or less degree, compressed, which is done on the up-stroke of the piston. Then by a simple, small, insignificant electric spark this compressed mixture is immediately transformed into a pressure and power-giving medium. There is an advantage that in the steam locomotive three or four pounds of fuel per hour per horse-power is used, whereas in the other engine one pound of oil is only required for the same duty. More experience is yet required with regard to control, reversal, and repairs; but these are comparatively small matters in the case of a desert railway, in which the water question is paramount; so that it may come to pass that the initiation of internal combustion traction for long-distance main lines may take place in the Antipodes, and serve us as a warning or example, as the case may be. In a recent number of the engineering supplement of the *Times*, attention was drawn to the possibilities of the "Diesel" oil locomotive. In this it was stated that so far it had not been used for locomotive purposes on road or rail, but, as had been announced a few weeks ago, Dr. Diesel is at work on a 1,000 to 1,200 h.p. Diesel locomotive. Steam locomotives have, of course, been made of much larger sizes, and this engine will not, therefore, improve on recent locomotive practice in this respect, but it may be expected to show very large economies in fuel consumption. The engine referred to is of the two-stroke cycle, four-cylinder type, having its cylinders arranged in pairs, at an angle of 90°. The engine is directly geared to the driving wheels, and does not transform its power electrically. An auxiliary engine drives the air-pumps for giving increased torque when starting, or when climbing a grade. The whole is expected to weigh about 85 tons. It will be seen that this locomotive gives the most direct form of challenge to the steam locomotive.

The Engineering Trades.—Practically all the engineering trades are under almost boom conditions, with the exception of that of steam-engine manufacture. Locomotive builders, hitherto lagging behind in their orders, are improving in this respect; this, in some instances, being due to Australian pressure, the local firms being unequal to the demand.

OBITUARY.

James Pitkin.—Mr. James Pitkin, who had been a member of the Society since 1871, died on August 20th at the age of eighty-six. Mr. Pitkin had carried on business for nearly sixty years past as a scientific instrument manufacturer, and as a maker of meteorological instruments he had acquired a considerable reputation. He is credited with having been the inventor of the pocket aneroid, that is to say, with having made the first aneroid of a portable character. He was also one of the first—if not the first—to construct a satisfactory portable electric lamp, for it was not long after the storage battery was perfected that he succeeded in producing a lamp which could be carried about, and was fitted with a compact and convenient battery. In it he used a perforated screen of thin vulcanite for the purpose of separating the leaden plates. This lamp attracted a good deal of attention at the time, and a large number of the lamps was sold. Mr. Pitkin was well known to many scientific men, who appreciated the excellence of his work, and was much liked by those with whom he came in contact.

GENERAL NOTES.

Olive - preserving in Spain.—Among the various kinds of olives grown in Spain, the variety known as the "Sevillanès" is particularly in demand for the South American market as well as for export to the United States. These olives, which often weigh as much as 15 grams (nearly ½ oz.) each, are preserved chiefly in Seville. After being steeped for a few days in an alkaline lye (prepared from wood ashes) in order to remove the bitter taste, the fruit is well washed in running water. The olives are then placed in large tubs filled with weak brine. Here they are allowed to remain for a few weeks, during which time a slight fermentation, indicated by the scum which forms on the surface of the liquid, sets up. The fruit is then taken out, sorted and put up dry, in jars, bottles, small barrels, or even packed in wooden boxes. The preservation of the olives is due to the fermentation, as is the case with the chopped cabbage of *Sauerkraut*. In Algeria, olives are

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sometimes treated in a somewhat similar fashion, and after being taken from the brine and dried they are rubbed over with olive oil, and put up in glass jars or wide-mouthed bottles which are closed hermetically. The olives treated in this way are richer in oil and darker in colour than those of Seville, and are much appreciated in France.

THE SHIPPING TRADE IN HOLLAND.—The shipping trade generally appears to have been good last year in Holland. During 1911, 2,358 vessels, representing a tonnage of three and a half millions, entered the port of Amsterdam. At Rotterdam the entries during the same period were 9,425 vessels, with a tonnage of 18 millions. The trade of Holland with her possessions in the East Indies is very considerable, and the Dutch flag, which in 1910 occupied the fourth place in the traffic through the Suez Canal, last year was the third in importance amongst the ships of other nationality. Shipbuilding was also very active in Holland last year. No fewer than 1,100 new vessels, with a registered gross tonnage of 223,180 tons, were launched during the year, 659 of which were less than 100 tons in burden. This year it is estimated that the output will be still greater, as the yards throughout the country are working to their full capacity, and many orders have been placed in the United Kingdom. Last year Holland imported to the value of £272,103,309 sterling, and exported to the value of £219,363,222, as compared with £261,450,052 imports and 204,562,613 exports in 1910.

DECREASE OF POPULATION IN FRANCE.—The decrease of the population in France is a fact which is causing considerable anxiety at the present time to statesmen and economists in that country. The number of births, which has fallen off from upwards of a million every year at the time of the Franco-German War, forty years ago, to 742,114 in 1911, as compared with the number of deaths, which was 776,983 during the same period, shows a loss of 34,869 inhabitants during the year. Whilst in other European countries the number of births as compared with the deaths increases every year, the movement of the population, if not quite stationary, at the present begins to show a downward tendency, as may be seen from the following table, which gives the number of births and deaths in France for the last ten years:—

Year.	Births.	Deaths.	Increase or Decrease.
1902	845,378	761,438	+73,940
1903	825,712	753,606	+72,106
1904	818,229	761,203	+57,026
1905	807,291	776,192	+31,099
1906	806,847	780,196	+26,651
1907	773,969	793,889	−19,920
1908	791,712	745,271	+46,441
1909	769,565	756,545	+13,020
1910	774,390	703,777	+70,613
1911	742,114	776,983	−34,869

OSTRICH-FARMING IN MADAGASCAR.—Ostriches were first imported into Madagascar in 1902, five pairs being offered to the Government and placed on a farm at Tulear. The beginning was hard, and a pair of birds died after a few months. The ostriches were then transferred to another farm, where their breeding became easier, owing to better climate and an abundant supply of grass. In 1904, the imported ostriches having reached their full growth, young ostriches were hatched, and in 1909 the farm had two hundred and twenty-eight birds. Trials with artificial incubation proved unsatisfactory, while natural incubation was successful. In the past few years, however, new incubators have been used, and the results have been promising. The acclimatising of the ostriches in the south-west of Madagascar has been entirely satisfactory, and the Government has just opened a new farm at Marovoay, near Majunga. The birds born in Madagascar are stronger than those which were imported. The race is improving, and it is expected that before long Madagascar ostriches will successfully compete with those of Cape Colony.

PRODUCTION OF PETROLEUM IN RUMANIA.—An Italian consular report from Bucharest states that the production of crude petroleum in Rumania during 1911 amounted to 1,544,072 tons, showing an increase of 191,665 tons, or 14·17 per cent. on the output of the previous year, which was 1,352,407 tons. The annual production of petroleum has increased steadily during the last five years, which was as follows:—

	Tons.
1911	1,544,072
1910	1,352,407
1909	1,297,200
1908	1,159,680
1907	1,129,080

MILKING MACHINES IN AUSTRALIA. — Milking machines, employed in New Zealand about four years ago, and since then much improved and developed in Australia, are coming into general use there, saving much time and labour for those engaged in dairying. The American Consul at Sydney says that demonstrations of these machines have been amongst the most interesting and popular features of agricultural shows in Australia, and he calls attention to several records of over one hundred cows being milked by these machines in less than two hours. The machines possessed the advantage not only of speed and economy, but also rendered the milking operation cleaner and more sanitary than when performed by hand. These machines are all made and worked on the natural principles of suction and compression, copying nature in the calf as closely as possible. One of these milkers is fitted with an automatic device called a "cut-out," which is only a float suspended on a valve spindle. Should the pail become full of milk this device comes into action, shutting off the power and ceasing to milk until the pail is emptied.

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Journal of the Royal Society of Arts.

No. 3,121. VOL. LX.

FRIDAY, SEPTEMBER 13, 1912.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE LOOM AND SPINDLE: PAST, PRESENT AND FUTURE.*

By LUTHER HOOPER.

Lecture II.—Delivered March 4th, 1912.

SPINNING MECHANISM AND THE LOOM FOR AUTOMATIC WEAVING, PLAIN AND ORNAMENTAL.

In the present lecture I shall first deal briefly with the spindle in its later development from the domestic spinning-wheel of the sixteenth century to the machines of extraordinary capacity and exactness which supply the enormous quantity of yarn of all kinds required in the textile industries of to-day. This will clear the way for the further and more important study of the loom as used for automatic plain and ornamental weaving.

On the primitive spinning-wheel, you will remember, I pointed out that the spinning of the thread, and winding it on to the spindle, were separate alternate operations. On the more modern spinning-wheels the spinning and winding are made simultaneous by means of a little contrivance called a flier and bobbin attachment to the spindle.

The first historic hint we have of this invention is from a drawing in one of the sketch-books of the great artist-craftsman, Leonardo da Vinci. But it was not until nearly a century after his death, which took place in 1519, that the spinning-wheel with this clever attachment came into general use.

Fig. 22 shows Leonardo's drawing and the later spinning-machine attachments which have been derived from it.

In Leonardo's drawing No. 1 is called the *flier*. It is firmly fixed on the end of a shaft or spindle No. 2 A and 2 B. No. 3 is a small pulley also firmly fixed to the spindle between the bearings C and D. When this pulley is made to revolve very rapidly, by means of a cord or belt from a large wheel, the flier revolves

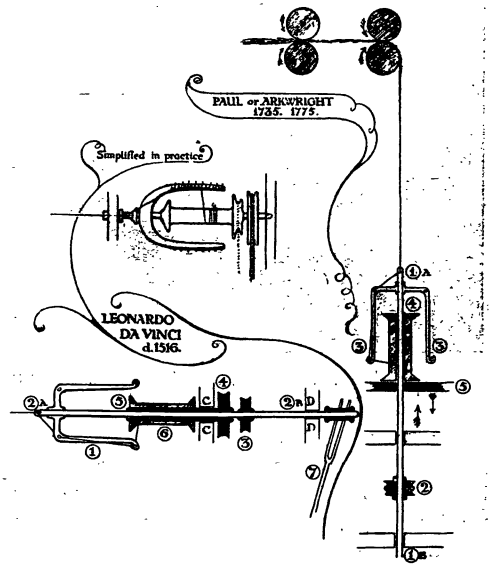

FIG. 22.—FIRST DRAWING OF BOBBIN AND THEIR ATTACHMENT FOR SPINNING-WHEELS.

with it and twists the thread which is passed through the hole in the spindle at No. 2 A.

No. 4 is another pulley, rather larger than No. 3. This pulley is fixed on a hollow shaft, which extends from the pulley to No. 5. In the hollow of this shaft the spindle can freely revolve, and on it the bobbin, No. 6, tightly fits.

Now, if the different-sized pulleys, Nos. 3 and 4, be actuated by cords from the same large wheel, the flier will revolve at a greater speed

* A large number of the illustrations are taken from Mr. Hooper's "Hand-Loom Weaving," and are reproduced by the courtesy of the publisher, Mr. John Hogg.

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than the bobbin, the difference in speed being, of course, in proportion to the difference in size of the pulleys.

The result of this arrangement will be that, if the thread, twisted by the revolution of the spindle, be passed through the eyes in the flier, as in the drawing, and fastened to the bobbin, two operations will take place: (1) the thread will be twisted by the flier; (2) because the bobbin revolves at less speed than the flier the thread will be gradually wound upon the bobbin.

No. 7 appears to be a kind of fork fixed to the end of the spindle. If this fork were pushed to the right, the eye of the flier could be placed at any part of the bobbin, so as to spread the yarn evenly upon it.

Sooner or later this suggestion of Leonardo's was practically adopted, and the spinning-wheel, fitted with bobbin and flier, came into general use in Europe. The distaff and spindle, however, have not, even to this day, been altogether superseded.

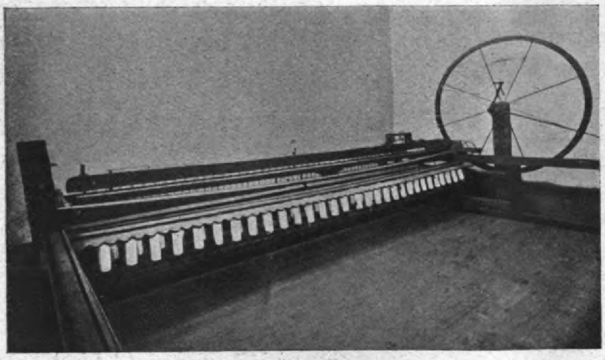

FIG. 23.—HARGREAVE'S SPINNING-JENNY.

A more compact and convenient contrivance for spreading the spun thread upon the bobbin is shown above Leonardo's sketch. In place of the fork for altering the relative position of the flier and bobbin, a row of small hooks is placed along the arm of the flier, by means of which the thread can be guided on to the bobbin at any part of its barrel. This is the twisting and winding arrangement with which the improved spinning-wheels of the seventeenth century in Europe were fitted up.

In order to compare it with Leonardo's sketch I have to the right of it (Fig. 22) made a diagram of the bobbin and flier of a machine spindle.

It is old-fashioned now, as a modification of it, called the ring spinner, has taken its place. The principle on which it works, however, is the same, so, as it is more convenient to compare with the original sketch, I prefer to use it.

Here Nos. 1 A and 1 B indicate the spindle which is caused to revolve by the pulley, No. 2.

The machine spindle is fixed vertically, a hundred or two being ranged on one machine.

The flier, No. 3, is fixed at the top of the spindle.

No. 4 is the bobbin standing on a shelf, No. 5. The shelf is made to rise and fall automatically as the thread is delivered to it from the flier. This is, therefore, a return to Leonardo's idea of the shifting spindle.

The spindle passes through the bobbin, but there is no hollow shaft for causing the bobbin to revolve. It simply stands loosely on the shelf, and when the thread from the flier is attached to it, the revolving flier drags the bobbin round at a less speed than its own, the weight of the bobbin acting as a brake. The thread is thus wound on more or less quickly, according to the weight of the bobbin.

In the ring spinner beforementioned the bobbin, or paper cop, is fixed firmly on the spindle and the flier is free. The flier runs on a ring which encircles the cop and drags upon it. This acts in the same way, as to winding, but makes it possible for the spindle to revolve at a much higher speed.

Although thus adopted for machine-spinning, the idea of a loose bobbin was not, I believe, a new one. Spinning-wheels had probably been previously fitted with loose bobbins, such as that shown in the diagram, above Leonardo's drawing. In this case the fixed flier is revolved by a pulley which is connected by a belt to a large wheel. The loose bobbin, if not heavy enough to act as its own brake, has a string which is lightly attached to some fixed part of the framework of the machine. This being passed over, the bobbin brake pulley can be easily made to regulate its drag to a nicety.

At the top of the diagram (Fig. 22) are shown two pairs of rollers, between which the fibres to be spun are being drawn out with such regularity as few spinners could boast of. In a machine such rollers are set in a series, at very accurate distances apart, and revolved in the direction indicated by the arrows. The front pair of rollers revolve more quickly than the second pair; the second pair than the third,

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and so on. Consequently, as the fibres pass between the series, they are gradually drawn out into a fine fleecy rove which, between the front rollers and the spindle, becomes twisted into fine even thread.

This system of drawing out fibres by means of rollers was invented by Paul in 1735, and made practical by Arkwright in 1775, when he patented it. His right, however, was disputed, and on trial the patent was annulled, but his adaptation of the system was soon generally adopted.

When describing, in the last lecture, the primitive spinning-wheel and the distaff and spindle, where the spinning and winding-on were done alternately, I should, perhaps, have remarked that the finest threads were always produced in this manner. It is not surprising, therefore, that, very early in the history of machine spinning it was found that very fine, delicate threads could

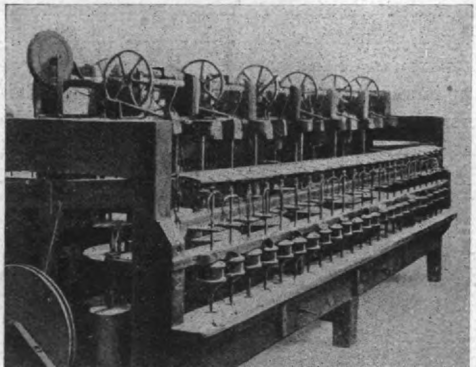

FIG. 24.—ARKWRIGHT'S WATER FRAME.

not be spun on the simultaneous principle. To overcome this difficulty, Crompton invented the mule machine, which imitates exactly the alternate twisting and winding of the primitive method of spinning. It was interesting to see, at the Anglo-Japanese Exhibition of 1909, the huge English machine of 250 spindles imitating with perfect precision the actions of a pretty girl, in the Japanese handicraft section, who was spinning gossamer thread on a primitive wheel, the same kind of wheel which had been in use in her country for a couple of thousand years or so, and which, we may hope, will be used for an indefinite number of thousands of years more by such charming little spinsters.

Messrs. Dobson & Barlow, Ltd., of Bolton, have courteously sent me five photographs of spinning machinery of great interest, which will require little explanation.

Fig. 23 is Hargreave's spinning-jenny.

Fig. 24 is Arkwright's water frame, so called because he used water as a motive power to drive it. It combines the *drawing rollers* with

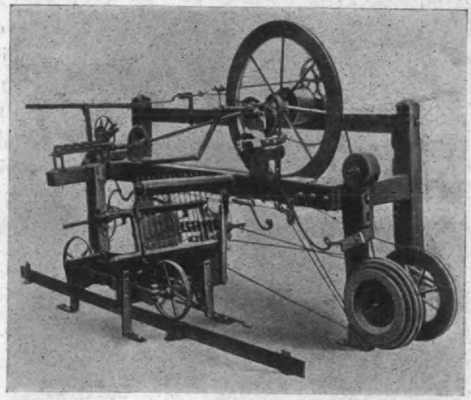

FIG. 25.—CROMPTON'S MULE. (Bolton Museum.)

the *flier and bobbin* attachment suggested by the spinning-wheel then in general use.

Fig. 25 is Crompton's mule, which he used in secret for some time, and mystified his neighbours by the quantity and quality of the yarn he produced.

Fig. 26 is a full-sized mule spinning-machine by Messrs. Dobson & Barlow, Ltd., of Bolton, which works on the same principle as Crompton's mule, and the Japanese girl I referred to just now.

Fig. 27 is a ring spinning-machine, working on the principle of this Italian peasant spinning-wheel. The driven bobbin and the loose flier.

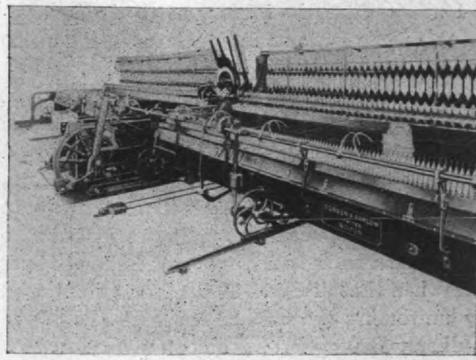

FIG. 26.—MODERN SPINNING MULE. (Dobson & Barlow, Ltd.)

[The lecturer here exhibited Italian and Belgian spinning-wheels, having a driven bobbin and a loose flier, and demonstrated how similar effects were obtained (1) by a separately driven bobbin

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and flier, (2) a driven flier and loose bobbin, and (3) by means of a driven bobbin and a loose flier.]

In conclusion, as regards the spindle, although we may congratulate ourselves on the perform-

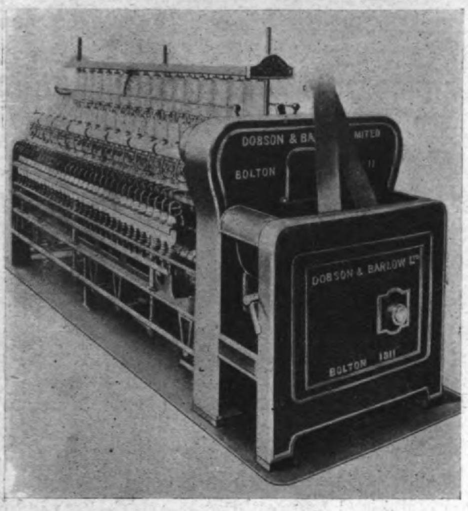

FIG. 27.—RING-SPINNING MACHINE.
(Dobson & Barlow, Ltd.)

ances of these wonderful thread-making machines and admire the inventive genius which has brought them to such perfection, it is interesting, though perhaps chastening and humiliating, to note that the untutored Hindoo spinner, squatting on the ground with a simple toylike spindle, can draw out and spin thread as fine, but infinitely stronger, than the most perfect machine of them all.

I now resume the inquiry as to the development of the automatic loom from the point arrived at at the end of my last lecture.

Four thousand years ago, more or less, probably at the time when the people of the Stone Age in Europe were cultivating flax and spinning and weaving its fibre into coarse cloth, the Chinese were inventing improvements in their primitive weaving appliances in order to adapt them to the weaving of an infinitely finer fibre than that of flax. This fibre was obtained by unwinding the case of the chrysalis of the mulberry-feeding moth, the caterpillar of which is familiarly known as the *silkworm.*

Chinese continuous written history goes back to that remote period, and tells that the annual festivals of agriculture and sericulture, which are still observed by the Chinese, were instituted by an Emperor and his wife, who themselves took leading parts in the festival, the Emperor ploughing a furrow and the Empress unwinding some silkworm cocoons. This practice their successors have continued to the present time.

This Empress is still highly honoured in China, and votive offerings are made to her at the festival. She is held in great regard as the benefactress who taught the Chinese how to prepare the silken thread for use and to weave it, thus enabling them to become the best and richest clothed people in the world. This pre-eminence they have maintained owing to their original monopoly, and expert knowledge of the cultivation and manipulation of the strongest, finest and most lustrous of all threads now called silk.

The silk fibre, on being unwound from the cocoon, is found to be a continuous, double thread of about the four-thousandth part of an inch in diameter. It takes from eighty to a hundred threads of natural silk to make up one thread of the size of the finest spun flax. It may be well understood, therefore, that special preparation of silk thread and specially delicate appliances are necessary for weaving it. This necessity proved to be, as is proverbially the case, the mother of many inventions, and there can be no doubt it is from the original

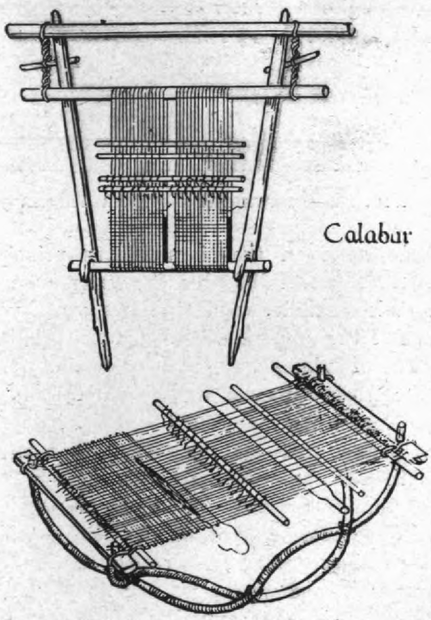

FIG. 28.—PRIMITIVE LOOMS.
(One fitted with two heddle rods.)

Chinese weaving appliances that almost all succeeding improvements in looms and loom fillings have been derived.

In order to describe the improvements in the loom required for weaving fine silk, reference must be made to Fig. 28, which shows a primitive loom fitted with a heddle rod for the purpose of raising the threads of the warp alternately with those raised by the shed stick.

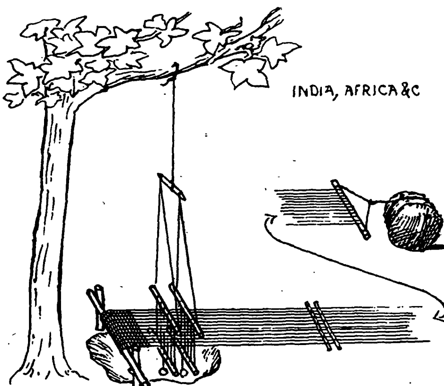

FIG. 29.—PRIMITIVE LOOM (India, etc.).

Two heddle rods in an upright loom would be no great, if any, advantage; but if the warp be placed horizontally the manipulation of the successive openings for the weft is much more convenient for the weaver, who sits at the end of the warp instead of in front of it.

Fig. 29 shows a very convenient form of Indian loom with the heddle rods suspended from the branch of a tree, and having the heddle loops connected with another pair of rods beneath the warp. The lower rods have strings hanging from them, each terminating in a ring. By placing one of his great toes in each ring, the weaver can pull down either set of loops at will, and make alternate openings for the shuttle carrying the weft. His hands are thus left free to manipulate the shuttle.

The addition of a long comb, equal in length to the width of the warp, was an immense improvement to the loom. The divisions in it were originally made of split reeds, hence it was called the reed, and is still so called, although the divisions are now always made of steel.

The effect of the long comb, with the warp threads entered in it, swinging in its heavy frame (see Fig. 30), was not only that the weft was beaten together more evenly and with less individual strain on the threads, but the width of the woven web was kept automatically the same.

Fig. 31 is a longitudinal section of the essential parts of a loom at the point of development now arrived at. It is lettered for reference. A is the roller on which the warp is wound in the first instance. B is the roller on to which the woven cloth passes. C C are the sticks preserving the cross which keeps the warp

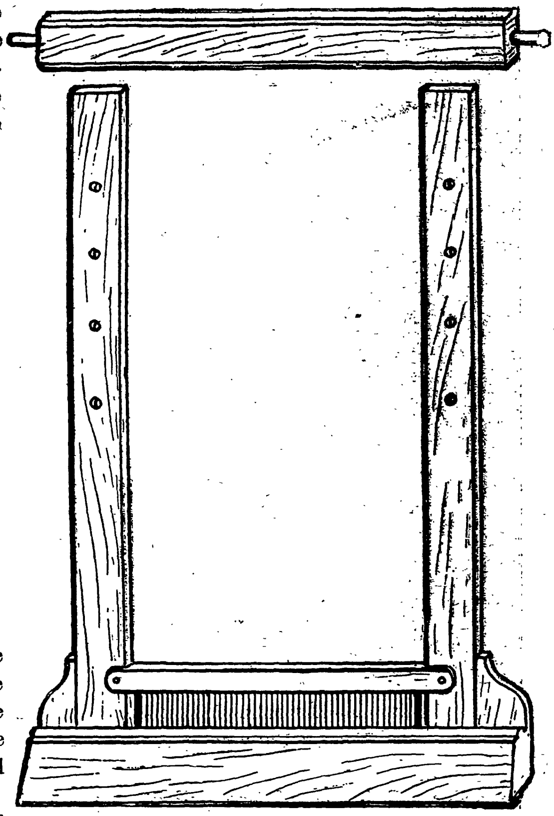

FIG. 30.—THE REED FITTED IN ITS FRAME.

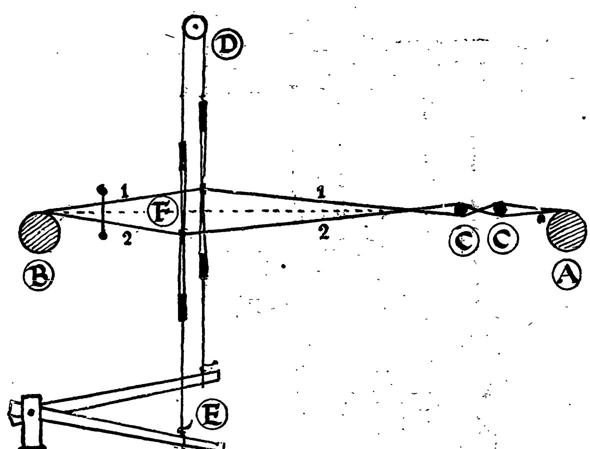

FIG. 31.—SECTION OF OPENED WARP.

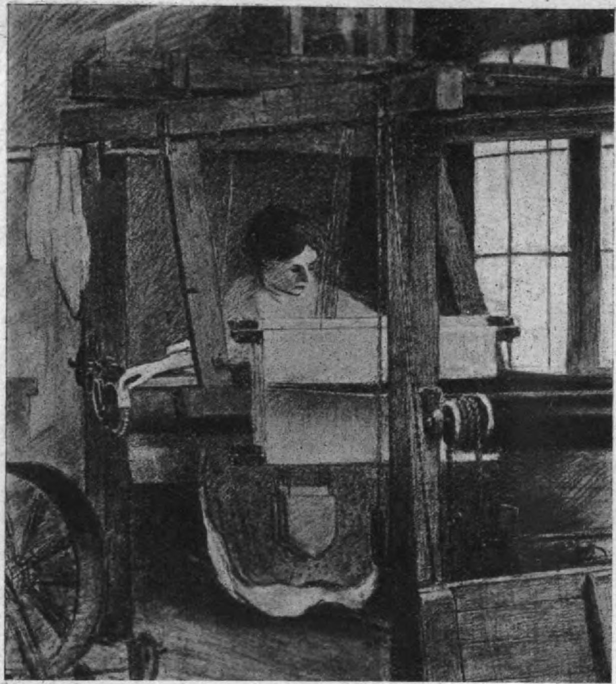

FIG. 32.—BETHNAL GREEN SILK WEAVER.
(From a Drawing by the Author.)

in order. D is one of two pulleys suspended from the top of the loom frame, over which cords pass after being attached to the ends of the top laths of the two heddles. At E are two treadles, which are tied to the lower laths of the heddles. Between the heddles and B the reed is shown suspended.

One treadle is represented depressed. This has pulled down one heddle and raised the other in consequence of the cord which passes over the pulley D. This movement has effected an opening in the warp at F, which, between the roller B and the reed, is wide enough for passing the weft through.

The successful weaving of plain silk necessitates a development of the loom to this point. It is, therefore, reasonable to credit the Chinese, who until the third century A.D. were the monopolists of silk and silk-weaving, with all these essential contrivances. Subsequently to the third century, these inventions spread through the East generally, and finally to Europe, first to Spain and Italy, then to France, Germany and England. It is remarkable that the loom of to-day, on which the very best silk fabrics are woven, should in all essential points be the same as the looms of ancient China.

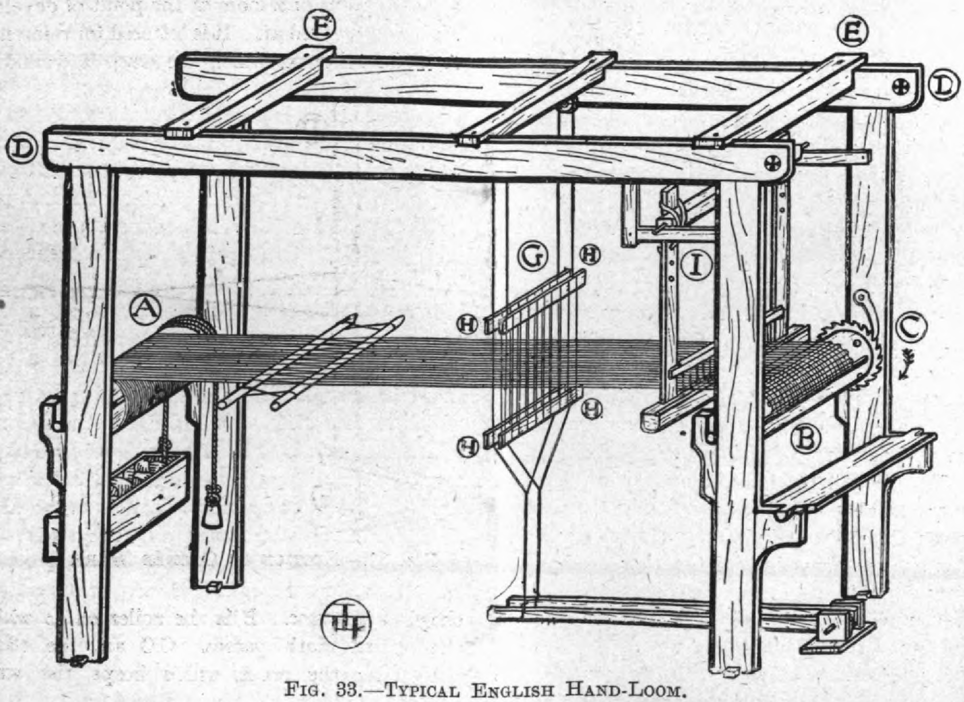

FIG. 33.—TYPICAL ENGLISH HAND-LOOM.

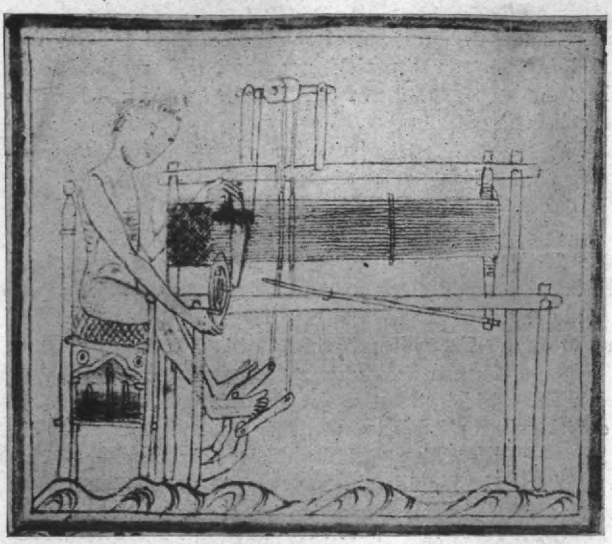

FIG. 34.—ENGLISH SILK WEAVER, FOURTEENTH CENTURY.
(From an old Manuscript.)

Fig. 32 is from a sketch I drew from life in a Bethnal Green silk weaver's workshop a few weeks ago. The weaveress is making a rich black satin, which will be all but perfect when it is cut out of the loom, and will require no after artificial finishing to make it ready for sale. The loom is arranged in the simple manner described, except that as the weaving of satin requires more heddles than plain silk, eight heddles instead of two only are shown.

The first impression given by Fig. 33, which is a diagram of an English loom, is one of sturdy strength. Strength and the perfect adjustment of the various parts of the loom are prime requisites where rapid and accurate weaving are desired.

Fig. 34 is from a manuscript of the fourteenth century, and represents an English silk weaver of the period at his loom. Whether the weaver is in correct costume I cannot say, but the loom and its fittings are quite recognisable, and like the loom of to-day, except for their slightness.

Fig. 35 is from a very old Chinese drawing. It is one cf a set of pictures representing the operations of sericulture. The first edition of the book from which it is taken is said to be of the twelfth century A.D.

It is the representation of a very perfect hand-loom for silk weaving. The weaver is shown sitting on the edge of a square hole in the ground, in which a set of treadles are seen. The framework of the loom is very carefully and solidly constructed. The front, or cloth beam, is shown with the reed hanging freely between it and the heddles. The back, or warp beam, is out of the picture, and the warp slants towards it after passing through the reed and heddles. The heddles themselves are very carefully fitted up, and are worked by means of the treadles in the pit, which are connected by cords to levers. These levers may be seen at the top of the picture.

The weaver, sitting in front of the loom, has just, by a blow of the reed, beaten up the weft, and is preparing to open the next shed and throw the shuttle which he holds ready in his right hand.

It will at once be noticed that the Chinese lcom (Fig. 35) has several heddles, instead of only two shown in the English loom (Fig. 33). In fact, there are two sets of heddles working together, one set having ten and the other five heddles.

The loom having two sets of heddles shows that some kind of pattern is being woven. As, however, at present I am speaking of the loom for plain or satin weaving, the second set of heddles need not concern us.

When the warp threads are very coarse and few in number, two heddles are sufficient for threading the warp, but when fine silk fabrics are to be woven, having three or four hundred threads to an inch, it is necessary to have several

FIG. 35.—CHINESE SILK-WEAVER'S LOOM.
(Ancient Chinese Drawing.)

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pairs of heddles in order to prevent the leashes, through which the silk is threaded, from being too crowded. In this Chinese loom the front harness, as a collection of heddles is called, consists of ten separate heddles. In all looms the threads of the warp are passed through the eyes in the leashes of the heddles in regular order.

The first thread is passed through the first eash of the first heddle, the second thread through the first leash of the second heddle, then through the first of the third, and so on until all are filled.

[The lecturer here drew a diagram on the black-board illustrating the method of entering a warp in the harness.]

To manage this set of ten, or any even number of heddles, only two treadles are necessary for plain or tabby weaving. The heddles are first

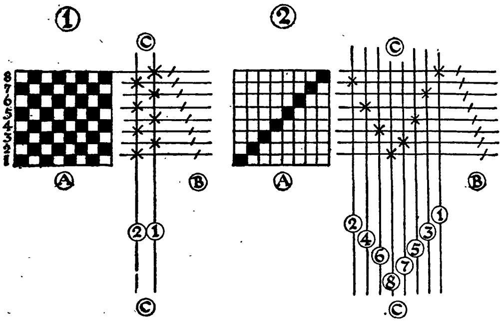

Fig. 36.—Plans of Tie-up.

joined together in pairs at the top, each pair having its two separate pulleys, as in the typical English loom (Fig. 33). The bottom laths of the first, third, fifth, seventh and ninth heddles are then all connected with one treadle, and those of the second, fourth, sixth, eighth, and tenth heddles are joined to the other treadle.

Now, it is manifest that if the first treadle be depressed half the warp, consisting of the first and all the odd-numbered threads, will be drawn down and the second and all the even-numbered threads will be drawn up. This will make the same opening for the weft as if there were only *two* instead of *ten* heddles.

In order to make this quite clear, the plan and tie-up of the pattern, as it is called, is given at Fig. 36.

This arrangement being at first made for plain tabby weaving of a close warp of fine threads, it would soon be discovered that by increasing the number of treadles and tying them to the heddles in different ways, the interlacements of warp and weft might be varied to an astonishing extent, and result in the production of an infinite variety of small patterns.

Fig. 37 gives, for example, four designs, which can be made on a loom fitted with four heddles and four treadles. If the threads of warp and weft are coarse enough, and the former white and the latter black, the designs would show as distinctly when woven as they do drawn out in the diagram.

There is not time, nor is it indeed necessary for our present purpose, to describe the way in which these designs are formed. All that is required is to note their possibility, and to show how this possibility affected the development of the loom itself.

A further examination of this ancient Chinese loom will show that, not only are there more

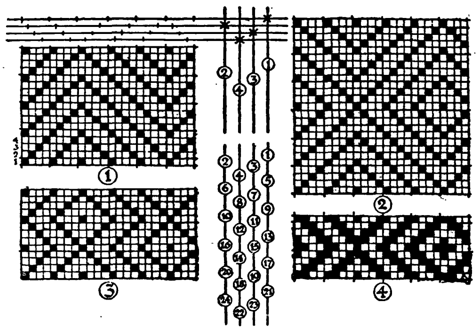

Fig. 37.—Simple Designs.

than two treadles in use, but instead of the heddles being tied together in pairs, as for plain weaving, each heddle is connected with one of a set of levers which in their turn are joined by a cord to the treadles.

Fig. 38 represents, without other details of the loom, two typical shedding motions, as any arrangement for opening the shed for the weft is called. In both these motions, as in the Chinese loom, the arrangement is one of heddles, levers and treadles connected together by cords. Below each diagram a longitudinal section of a loom at work is shown.

It is interesting to note that these ancient shedding motions are still in use. Silk fabrics made on hand-looms fitted with these motions cannot be equalled by webs woven on any machine-loom yet invented.

Fig. 39, which I drew from a Bethnal Green workshop, as it now is, shows a silk loom with precisely the same fitting up as the Chinese artist has drawn.

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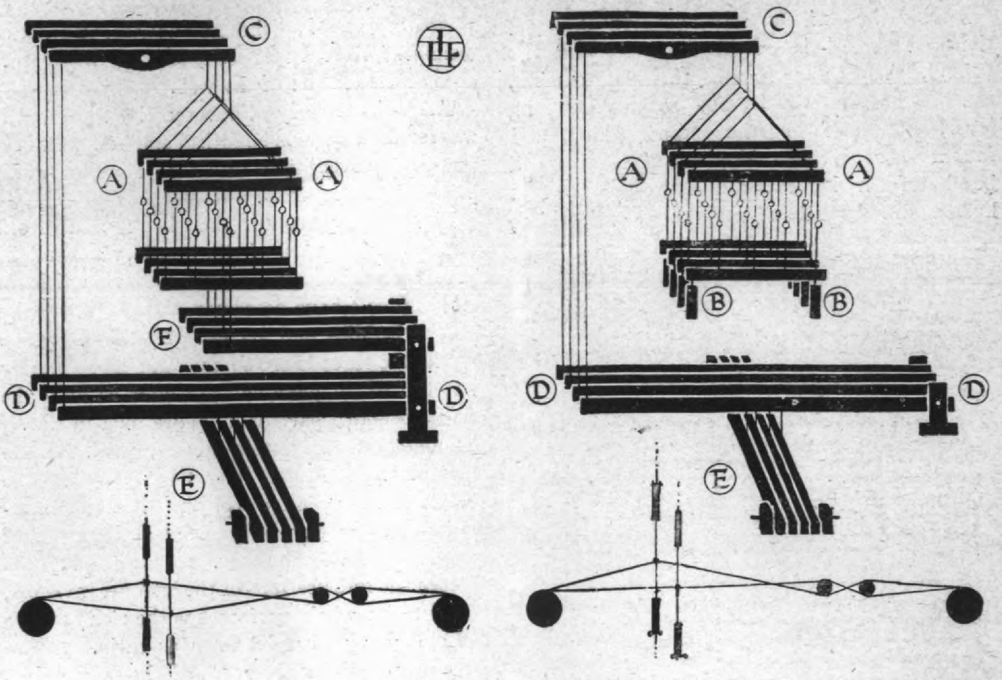

FIG. 38.—SHEDDING MOTIONS.

To return to the shedding motions (Fig. 38). In the right-hand figure the heddles A A have lead weights, B B, on their lower shafts. If, therefore, any of the four heddles be raised, as soon as they are released the weights will bring them down to their normal position. At the top of the loom, letter C, four short strong levers are fixed on an iron rod, which passes through a hole in their centres. From one end of each of these levers a heddle is suspended; and from the other end a cord hangs and connects each short lever with a long one, D D, which hangs across the loom below the heddles and above the treadles, which are lettered E.

It will now be seen that if any one or more of the long levers be tied to any one of the treadles, the weaver sitting in the loom has only to select and press a treadle in order to raise any arranged combination of warp threads for the weft to pass under, as it is carried by the shuttle through the opened shed.

The character of the shed made by this motion is shown below. The horizontal line is the normal position of the warp. The opening is made by raising certain selected threads.

An examination of the section below No. 2 will show that in it not only are certain threads of the warp raised, but all others are lowered, and the horizontal line of warp has disappeared. This is effected by adding to the motion another set of short levers, marked F, between the long ones and the heddles, and connecting the lower shafts of the heddles with them after

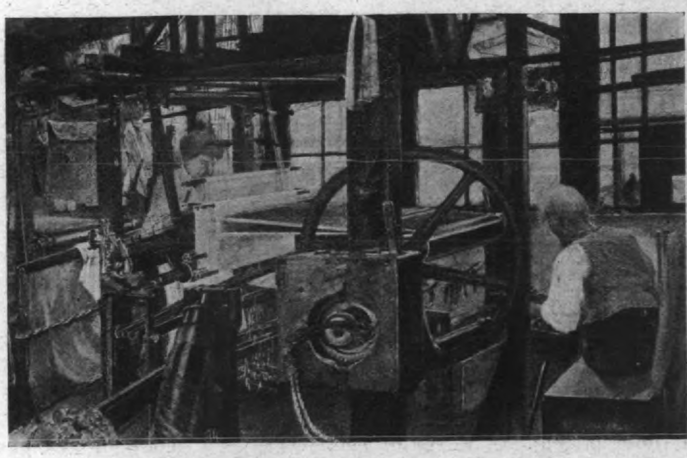

FIG. 39.—BETHNAL GREEN WEAVING SHOP, 1911.
(From a Drawing by the Author.)

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removing the weights. If now, for example, the first thread be required to rise and the second, third, and fourth threads to sink, the first treadle will be tied to the first long lever, and also to the second, third, and fourth short levers. The result of this will be that when the treadle is depressed the first heddle will be raised and the second, third,

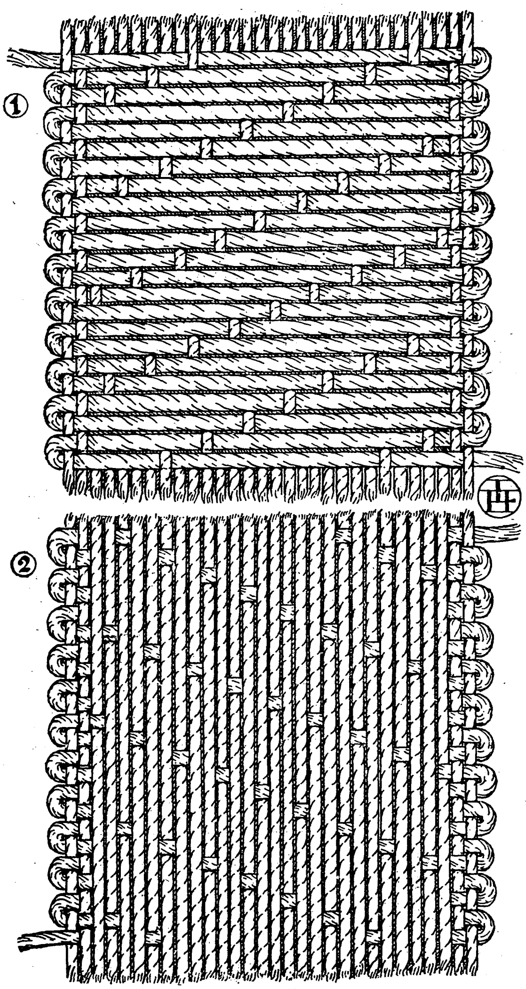

Fig. 40.—Satin Cloth (much enlarged).

and fourth heddles will sink, thus making the required shed.

These are typical shedding motions. All other motions are based on one kind or the other of these types, each kind having its advantages for certain classes of weaving.

I have already pointed out that such patterns as those of Fig. 37, woven of single threads, require the thread itself to be coarse in size in order to show as designs. But such designs, woven in fine silk, although indistinguishable as *ornament*, have a marked effect on the appearance of the texture of the web.

The Chinese early discovered this fact, and it was for their various beautiful and rich textures that the woven silks of China were so much prized in classic times.

Fig. 40 represents the back and front surfaces of a square of silk textile, which might have been woven in ancient China on a loom fitted up as I have described. It would require sixteen heddles and sixteen treadles to weave it, and the threads are so fine and lie so closely that the whole piece shown would be only the one-thousandth part of a square inch in size.

Looking at the lower square, which is the front of the material, it will be seen that the surface is nearly all warp, and that the intersections of the weft only occur at intervals of sixteen spaces each way. In cloth of this pattern the intersections of the weft are invisible, therefore its whole surface has the rich texture and glossy appearance known as satin. In the same proportion as the front of the satin web is nearly all warp, the back, of course, displays the weft. In pattern weaving these effects are called respectively warp satins and weft satins.

Satins may be made on different numbers of heddles, from five up to twenty-four. Fig. 41 shows several of them draughted on designers' ruled paper.

The next step in the evolution of the loom was to adapt it for distinct pattern weaving. This was effected by adding a second set of heddles to the harness, making it what is called a *compound* harness.

This compound mounting is shown in the Chinese drawing. The front set of ten heddles is for making the groundwork of the fabric, and the back set of five is for raising the *figure*, as the design is usually called in weaving.

Here is a very simple figure (Fig. 42), which will well illustrate the method of double harness pattern weaving. It is of a kind, too, of which the Chinese are very fond, having spots of ornamental shape powdered over a plain ground. Moreover, it could be woven on a loom fitted up exactly as in the Chinese picture.

The ground of this design is a plain tabby silk. I have already shown how this can be woven in a harness of ten heddles by means of two treadles. Five other treadles would, however, have to be added in order to work the figure harness, one for each heddle.

For double harness weaving, too, the leashes of the heddles of the front harness have an

important peculiarity which must be described; for, though simple, it plays a most essential part in all pattern weaving with compound harness.

In this class of weaving each warp thread passes first through the eyes of the figure harness and then through those of the front harness, which makes the ground. Now, if both harnesses are alike fitted with leashes having the ordinary short eyes, only the front one can affect the shed. This is because any threads raised by the back harness are prevented from effectually rising in the reed by the leashes of the front harness.

If, however, the front harness eyes are made long enough to allow the warp threads to be lifted, the back harness will be free to affect the shed at the same time as the front harness, or to affect it alternately, as may be required. The diagram, Fig. 43, will make this clear.

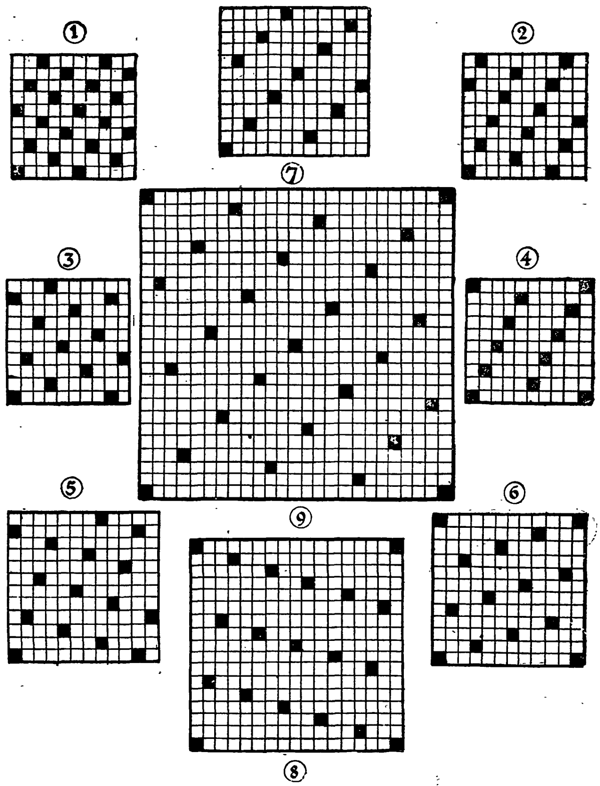

FIG. 41.—SATIN TIES.

If, now, we turn again to Fig. 42, the part played by the figure harness can readily be explained.

The points to notice are: (1) Two extra wefts are required for weaving in the design which has two separate colours of its own; (2) the figure is formed by allowing the coloured weft, in certain places, to pass over two threads of the warp instead of one; (3) the necessity for five heddles in the figure harness is to be gathered from the fact that five different combinations of pairs of rising threads are required to complete the design; (4) as the figure throughout is made by two threads rising together, two threads together may be entered in each eye of the figure harness.

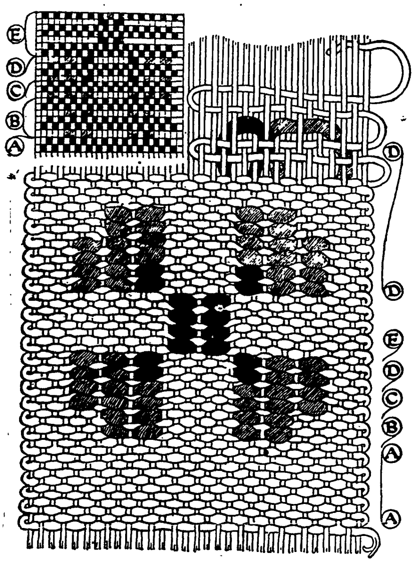

FIG. 42.—DOUBLE HARNESS WEAVING.

If this explanation is clear, it is only necessary to add that in silk weaving, not only *two*, but sometimes as many as *twenty* warp threads are entered in each leash eye of the figure harness. Therefore it is evident that the possible scale of ornamentation and scope for the designer are immensely increased. For instance, this figure woven on two threads, as explained, on a fine silk warp of 400 threads to an inch would only occupy the sixteenth of an inch in width and height, but if twenty threads were entered together in each leash eye of the figure harness the size of the ornament would be increased ten diameters, and would occupy nearly a square inch of surface.

There is, therefore, represented in this old Chinese drawing (Fig. 35) a very perfect loom for weaving small designs of simple

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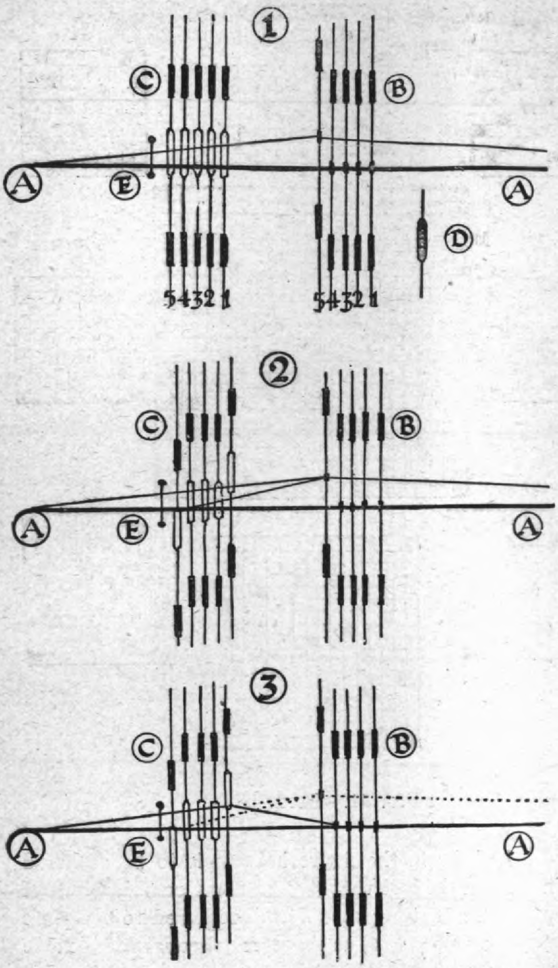

FIG. 43.—DOUBLE HARNESS SHED SECTIONS.

construction. The limit of size and elaboration of the pattern in this kind of loom is, however, reached when the number of figure treadles and heddles becomes too great for practical use. There is no evidence of the Chinese having endeavoured to weave with an elaborate system of heddles and treadles such as were ingeniously devised in England in the eighteenth century, but which, being very difficult to fit up and manage, were soon superseded.

Fig. 44, taken from the same Chinese book as the foregoing Chinese drawing, shows, in a compound loom, a figure harness of entirely different construction, which is evidently made on the same principles as the perfected European draw-loom of the eighteenth century, on which were woven the most sumptuous and intricate webs which the weaver's art has ever produced.

In this representation of a pattern weaving loom, instead of the small figure harness of five heddles, a large one of quite different build is shown. Over this harness an assistant weaver, perched aloft at the back of the loom, is presiding. He is, in fact, drawing up, according to an arranged plan, certain groups of threads required for the formation of a pattern. The all-important part of this picture is the portion of the loom over which the assistant weaver is presiding.

Taken by itself, it is a complete loom harness of remarkable capacity. In fact, for automatic pattern weaving, a loom fitted with this contrivance for raising the warp threads only is as complete in its way as the perfected primitive loom is for tapestry weaving, as I pointed out in the last lecture.

Although the Chinese picture represents what is unmistakably a draw-loom apparatus, it is not clear enough in detail to describe the machine from. I must, therefore, have recourse to a diagram (Fig. 45).

Here, at No. 1, I have represented in diagrammatic form the simple draw-loom, and at No. 2 a design on ruled paper suited to its capacity, which is purposely kept very limited for the sake of clearness.

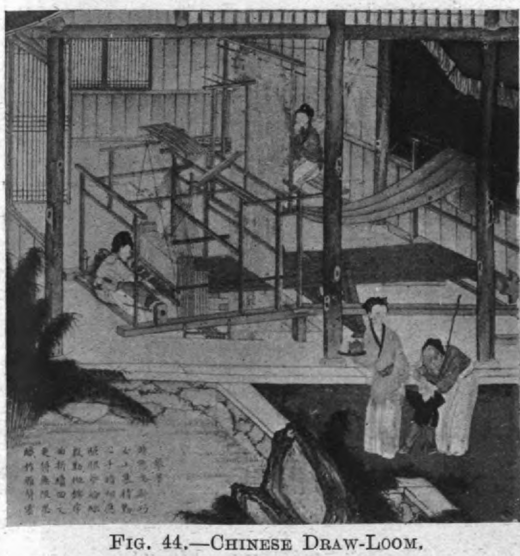

FIG. 44.—CHINESE DRAW-LOOM. (From an ancient Drawing.)

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The whole mechanism of the draw-loom centres in the comber board and leashes which hang in the loom in place of the ordinary harness of few or many heddles. The advantage of the comber board monture over the ordinary heddle harness is that whatever width a design may be, even to the whole extent of the warp, the monture takes up no more longitudinal space in the loom than a harness of a few heddles.

The comber board, No. 3, is simply a board pierced with a number of holes equal to the number of threads of the warp which it is to govern.

In each of these holes a separate leash is hung. Each leash has a long, thin lead weight at its bottom end; and in its centre, instead of a string loop, a glass eye called a mail, through which a warp thread is entered.

The comber board in the diagram is only pierced with seventy-two holes, consequently it is only for a warp of seventy-two threads. If it were for seventy-two thousand threads of fine silk it would not take appreciably more space in the loom.

The draughted design at No. 2 is made on eighteen lateral squares, so that it would repeat four times in the width of the web to be woven.

The word "comber" board is derived from an older word, "camber," which used to signify the repeats of a design as regards width. The board was called a camber board because the holes pierced in it were accurately apportioned to the number of threads in each pattern repeat, and the width of the total number of holes was the same as the width of the warp.

In this comber board (Fig. 45) there are holes for four repeats, of eighteen leashes, but only six leashes of each repeat are shown in position, as more would confuse the drawing.

The bottom board of the triangular box, C, is pierced with eighteen holes, the same number as that of the threads in each repeat of the design.

Let us suppose the comber board to be filled with leashes, one suspended in each hole; also that eighteen cords are hanging through the holes in the triangular box at D.

The monture builder now connects, with fine cord, the *first*, *nineteenth*, *thirty-seventh*, and *fifty-fifth* leashes, which are the *first* in every repeat, with the *first* hanging cord at D.

He next takes the *second* leash in each repeat, and connects it in like manner with the *second* cord at D.

He proceeds thus in regular order to connect *leashes* and *top cords* until he reaches the last of the repeats, leashes *eighteen*, *thirty-six*, *fifty-four* and *seventy-two*.

When this work is done it is apparent that if any *one cord*, at D, is drawn up into the triangular box the corresponding leashes in *every repeat* will be drawn up through the comber board to a corresponding height.

Moreover, if seventy-two threads of warp are entered in the leash eyes, the selected leashes

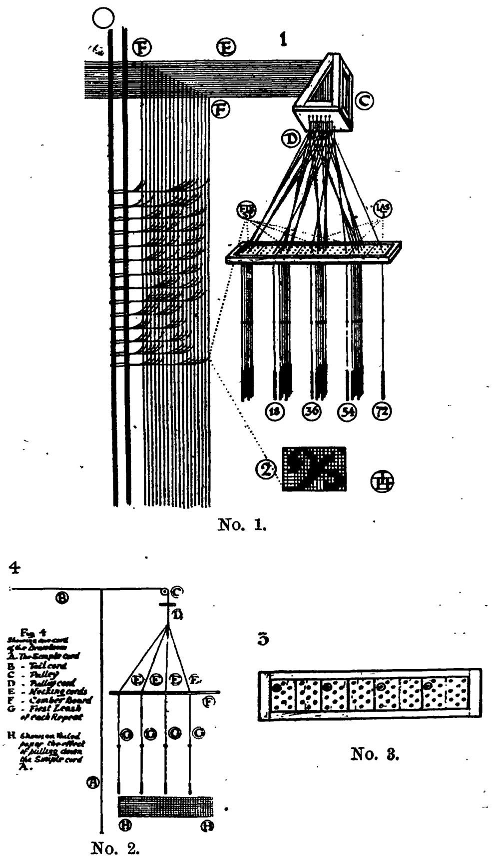

Fig. 45.—Draw-Loom Diagrams.

as they rise will raise the threads necessary for the formation of the pattern shed.

This is the essential portion of the draw-loom, and so far is it from being obsolete that all the pattern-weaving looms of to-day, whether worked by hand or power, are identical with it. Thus the immense textile industry of modern times is indebted to, and linked with, the invention and industry of ancient China.

Vast numbers of different methods of drawing up the cords of the loom were no doubt practised

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in the East. Most frequently, as in the Chinese picture (Fig. 44), the weaver's assistant who did this work sat above the loom drawing the cords line by line according to a written or painted draught.

There is no evidence to show what form this part of the loom had assumed when the art of silk pattern weaving was introduced into Sicily in the twelfth century. The rapid development of silk weaving in Sicily and Italy, which we know took place, makes it more than probable that the convenient method of drawing the cords from the side of the loom, as shown in this diagram (Fig. 45), was invented soon after the art was introduced. However, *when* introduced or *by whom* invented, it is certain that it was on looms mounted and fitted up in this manner that the masterpieces of the weaver's art, made in Europe from the thirteenth to the eighteenth centuries, were produced.

I resume the explanation of the diagram of the draw-loom (Fig. 45) at the point D, where the eighteen cords are seen to enter the triangular box, C. This box is fitted up with pulleys, eighteen in number. Each cord passes over a pulley and is seen again at E. The collection of eighteen cords, called the tail of the monture, is then securely fastened to the wall of the workshop, or some convenient strong post.

Between F and F another series of eighteen cords, called the simple, is tied to the tail series and fastened to the ground.

A simplified diagram, showing one cord in all its parts, is given in No. 4.

Now it will at once be seen that if the cord, A, be pulled down by an assistant standing at the side of the loom, the eyes of the leashes, G, through which the warp threads pass, will be pulled up.

It is necessary, then, in the *simple*, to have as many cords as there are threads, or groups of threads, in each repeat of the comber board. And it is possible to weave on the loom any design, of whatever length, that can be drawn on the number of threads arranged for in each repeat.

If we turn to the design No. 2 we shall see that it is drawn on eighteen squares, and if we compare the design with the loops tied from the large guiding cords to the separate cords of the simple, we shall see that they agree. The black squares in the design represent a tie. Take the first line, beginning at the left-hand side. Here are six black squares. If we follow the dotted line to the first cord of the simple, a group of six ties will be found. Then, passing over six cords, a group of four ties are found which correspond with the four black squares in the third division of the sketch.

By means of these loops the draw-boy, as he was called, selected the cords for pulling down, and, having gathered them together on the prong of a large fork, to which a lever was attached, he pulled the lever and drew the leashes up, thus opening the shed for the weaver's shuttle.

The design had to be tied up on the simple cords line by line before weaving could commence; but when this was once done the draw-boy had only to pull the cords, in regular sequence, in order to repeat the design continuously in the length of the web.

On this mounting of the loom entered with single threads of warp any possible interlacements of warp and weft can be worked out. It may well be called, therefore, the most perfect loom. Its only limitation is in the size of the design. It would require a simple of 400 cords to tie up a design one inch wide for a silk web 400 threads to an inch.

This difficulty was surmounted by adopting the compound harness arrangement I have already described. It is shown in the Chinese drawing of the pattern-weaving loom (Fig. 44).

If threads, entered singly in the front harness, are lifted in tens by each leash of the figure harness, the design will be woven ten inches wide instead of one inch. The simple and tie-up being no more extensive or complicated.

More elaborate interlacements of warp and weft were arranged for by dividing the comber board into two or even three parts, each governed by a separate set of simple cords, as well as by adding more warps and rollers to the loom, and additional harnesses of heddles for binders and stripes of satin, tabby or tobine effects. In fact, there seems to be no limit to the different combinations the skilful designer may invent and provide for in this most perfect and adaptable of all craftsman's tools, the compound draw-loom.

In my third lecture I shall describe the *Jacquard* machine, and some other important weaving inventions of the eighteenth century, the evolution of the *power-driven* loom, describe a new *circular* loom, and indicate some possible developments of the weaving-machines of the future.

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ZOOLOGICAL GARDENS.*

There are now more than a hundred public zoological gardens in existence, of which twenty-eight are in the United States, twenty in the German Empire, five in England, one in Ireland, and none in Scotland. I hope that the efforts of the Zoological Society of Scotland will be successful, and that before many months are over there will be a zoological park in the capital of Scotland. There is no reason of situation or of climate which can be urged against it. The Zoological Society of Scotland would have the great advantage of beginning where other institutions have left off; it would be able to profit by the experience and avoid the mistakes of others.

The Zoological Society of London would welcome the establishment of a menagerie in Scotland, for scientific and practical reasons. I may mention two of the practical reasons. The first is that Great Britain labours under a serious disadvantage as compared with Germany with regard to the importation of rare animals. When a dealer in the tropics has rare animals to dispose of he must send them to the best market, for dealing in wild animals is a risky branch of commerce. If he sends them to this country there are very few possible buyers, and it often happens that he is unable to find a purchaser. If he sends them to Germany, one or other of the twenty gardens is almost certain to absorb them, and failing Germany, Belgium and Holland are near at hand.

Were there twenty prosperous zoological gardens in Great Britain they could be better stocked, at cheaper rates, than those we have now. The second practical reason is that it is a great advantage to menageries to have easy opportunities of lending and exchanging animals; for it often happens that as a result of successful breeding or of gifts, on the one hand, or of deaths, on the other, a particular institution is overstocked with one species or deficient in another.

Menageries are useful in the first place as educational institutions, in the widest sense of the word. For that reason zoological gardens should be associated in some form with elementary and secondary education. Menageries provide one of the best schools for students of art, for nowhere else than amongst living animals are to be found such strange fantasies of colour, such play of light on contour and surface, such intricate and beautiful harmonies of function and structure. They also provide a rich material for the anatomist, histologist, physiologist, parasitologist, and pathologist; but there remains the fundamental reason for their existence, that they are collections of living animals, and therefore an essential material for the study of zoology.

Systematic zoology, comparative anatomy, and even morphology, the latter the most fascinating of all the attempts of the human intellect to recreate Nature within the categories of the human mind, have their reason and their justification in the existence of living animals under conditions in which we can observe them. Certainly we like to have many species, to have rare species, and even to have new species represented in our menageries. But what we are learning to like most of all is to have the examples of the species we possess, whether new or old, housed in such a way that they can live long, and live happily, and live under conditions in which their natural habits, instincts, movements, and routine of life can be studied by the naturalist and enjoyed by the lover of animals. Space, open air, scrupulous attention to hygiene and diet, the provision of some attempt at natural environment are receiving attention that they have never received before.

However we improve the older menageries, and however numerous and well-arranged the new menageries may be, they must always fall short of the conditions of Nature—another reason for the making of zoological sanctuaries throughout the world. If these are devised for the preservation of animals, not merely for the recuperation of game, if they are kept sacred from gun or rifle, they will become the real zoological gardens of the future, in which our children and children's children will have the opportunity of studying wild animals under natural conditions. We must use all avenues to knowledge of life, studying the range of form in systematic museums, form itself in laboratories, and the living animal in sanctuaries and menageries. And we must keep all avenues to knowledge open for our successors, as we cannot guess what questions they may have to put to Nature.

* Extracted from the Presidential Address of Dr. Chalmers Mitchell to the Zoological Section of the British Association.

OLD DUELLING DAYS IN CALCUTTA.

Some recent reflections in an Indian periodical on the practice of duelling as carried out in the early days of John Company prove, from the numerous rencontres that took place in the eighteenth century, that the custom obtained as firm a footing in India as it had in Europe, whence, of course, it was imported. In those days the healthy occupations and outdoor exercises which now serve to distract and fill up leisure time were often wanting; gambling and drinking were far too prevalent, and there was a lack of the social and humanising influence of cultured ladies which is found nowadays in nearly all up-country stations and, of course, to a much greater extent in the towns. It is said that formerly a young officer could not go through his period of service without being subjected to one or more challenges, and even the mildest-mannered seniors were occasionally the worst offenders.

There were two "trees of destruction" at Kidderpore, where, in the early hours of the morning, "affairs of honour" were customarily settled. Sometimes, in case of a fatal result, cholera was given out to be the cause of death,

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and the funeral was carried out with military honours.

The great majority of duels were fought with pistols, but the *Calcutta Chronicle* of May 21st, 1793, notices an affair which came off with small swords within an apartment. This, however, was altogether exceptional. Military men were, as might be supposed, the most inveterate supporters of the practice, but civilians were almost as frequently involved. J. H. Stocqueler, editor of the *Englishman*, and J. Silk Buckingham, of the *Calcutta Journal*, were in their days concerned in several duels. In 1837 a dispute arose between Stocqueler and Captain Sewell as to some criticism in the former's journal regarding the quality of the food supplied to the inmates of Kidderpore House, which was a Government institution. The editor, refusing to withdraw his animadversions, was challenged by the captain, who secured the services of a brother officer as second, Mr. Stocqueler being attended by Mr. Buckingham. The meeting took place at Howrah. The soldier fired first and missed, whereupon the civilian fired his pistol in the air, and the affair was settled by the seconds declaring that "honour was satisfied."

Mr. Stocqueler was a clever and indefatigable *littérateur*. One of his last experiences, towards the close of a long and busy life, was to enter the India Office in the early seventies as a temporary clerk, on the nomination of the late Duke of Argyll. He did not, however, remain there long, and died shortly after.

One of the most famous and historic encounters of early days was that between General Clavering and Mr. Richard Barwell in 1775. From the account given by Mr. Beveridge in his volume on Backergunge, it appears that Barwell held the lease of a couple of Government salt farms which he sub-let to two Armenians, on condition that his personal consideration in the transaction was to be a bonus of a lakh and 25,000 rupees (£7,812). Unfortunately, even this handsome profit did not appear to satisfy him, for one of the Armenians subsequently complained that Barwell had turned him out and re-let the farm to someone else for an additional lakh of rupees (£6,250). When taxed with being guilty of this discreditable transaction, Barwell boldly contended that he was within his rights. Accordingly, at a meeting of Council, General Clavering rose and called on Mr. Barwell to say how he held such a proceeding to be consistent with his oath to the Company. Barwell, probably conscious that he had no case, tried to ride off by grossly insulting his accuser. He replied with heat, "Whoever says I have done anything inconsistent with my oath to the Company is a rascal and a scoundrel."

Clavering, incensed at the insult, clapped his hand to his sword, whereupon Barwell bowed and retired. At the ensuing duel the General fired and missed; but Barwell declined to fire at all, a proceeding which in those days seems to have had a particularly irritating effect on any antagonist. In fact General Clavering threatened, if Barwell continued in his refusal, to fire a second pistol; but in the end, owing, it is said, to the intervention of the seconds, matters were peaceably arranged by Barwell's promise to apologise. A romantic element to the story is supplied by the fact that Barwell was much attached to the General's daughter.

The encounter between Hastings and Philip Francis was still more famous. The conduct of the latter had for some time occasioned the Governor-General the gravest displeasure, and in consequence the latter wrote in one of the minutes of Council a severe denunciation of Francis and his reprehensible ministerial misdeeds. Out of this a challenge would be the inevitable result, and, apprehending this, Hastings sent Mrs. Hastings out of town and waited till Francis, who was suffering at the time from a slight attack of fever, was sufficiently recovered to attend Council. Then Hastings read out the accusatory document in all its severity, and the same evening received a challenge from Francis. The parties met the next morning in the vicinity of Belvedere, the seconds being Colonel Watson and Colonel Hugh Pearse, and the distance measured out was fourteen paces. On the word being given both men fired, and Francis fell. Hastings immediately ran to the side of Francis, saying that, if anything serious happened to his opponent, he would surrender himself to the Sheriff. Pearse ran to summon assistance, and returned with a sheet which was wrapped round the wounded man in order to stop the bleeding. He was taken in Pearse's carriage to Belvedere, where he was attended by two doctors, one being Hastings' own medical attendant.

Most of the above facts are corroborated by Warren Hastings' own hand in a very interesting letter addressed by him to his wife, beginning "My dear Marian," and exhibited in Case IV. in the British Museum, in the Manuscript Saloon adjoining the Grenville Library.

In those days there stood, not far from Calcutta, an institution known as the Baraset Military College, where young men from English public schools were prepared for cornetships in the Company's army. What would be now termed "ragging" was then rife, and General Sir J. B. Hearsey, writing of his college days, says:—

"I usually studied Urdu by candle-light as my days were spent in sport, and I was often disturbed by the young men who saw me thus employed. They threw clods into my room, which frequently hit me or my *munshi*, or broke and extinguished my light. One close night, being disturbed in this manner, I ran hastily to the open window and caught a glimpse of one of the cadets endeavouring to hide. I shouted out, 'I know who you are, and you shall hear from me to-morrow morning.' About two minutes afterwards the door opened, and a young man came in smiling and innocently remarking, 'So, as usual, you are studying at night.' In him I instantly recognised the offender, and, seizing the thick quarto volume of Gilchrist's Dictionary, I struck

him down with it, telling him to quit the room, and I should be ready to give him the satisfaction due from one gentleman to another on the morrow. However, he never called again."

Mr. Keene tells of two jovial brothers, one an officer of the Bengal Cavalry and the other a kindred spirit in the line, who happened to meet at the mess-table of a native regiment a pair of cadets who were on the way up country to join for the first time. The apparent simplicity of these youths tickled the frolicsome brothers, who were warm supporters of the institution of duelling, and when the two cadets got into a dispute over a game at cards, the wicked seniors declared that single combat could only satisfy honour. It was faintly objected that the night was too dark, but this was overruled by the senior brethren declaring that each of them would hold up a wall lamp. Accordingly the party proceeded to the mess compound, but on the way the two cadets contrived to nudge each other, and, without being observed, to decide upon a small conspiracy. The combatants were placed opposite each other with loaded pistols in their hands at twelve paces, while their friendly mentors took up the other corners, each holding a light. The word was given, the youngsters fired, and with a crash of glass each lamp fell shattered and extinguished to the ground from the well-aimed discharge. It is not recorded what the two senior officers said or thought of the affair.

Many other noteworthy encounters are on record, but the decay of duelling in England was inevitably followed by its discontinuance in India, though the latter was very gradual. It was not till 1843, when an association of officers, civilians, noblemen and others was formed to discourage duelling, that the rise of a new public opinion succeeded in overcoming the bad but time-honoured custom.

TRADE OF THE PORT OF LE HAVRE.

As a commercial port, Le Havre is the second in importance in France. Next to Marseilles, where the total movement of shipping amounted to 15,751,797 registered tons in 1909, that of Le Havre shows a total of 12,251 ships and 9,265,897 tons during the same period.

Next in importance to Le Havre follows Dunkerque, with a movement of upwards of four million tons annually, Bordeaux slightly less, and Rouen with 3,800,000 tons per annum.

During 1910, 12,343 ships, with an aggregate of 9,571,904 tons burden, entered and left Le Havre. Last year the total tonnage was 10,038,650, which, compared with that of the previous year, shows an increase of 466,746 tons in favour of 1911. This increase, in a great measure, may be attributed to the deficiency of the grain crops in France, which necessitated the importation of foreign corn.

The trade at this port has made remarkable progress during the last ten years, when it was 5,747,000 tons as compared in round numbers to 9,572,000 tons in 1910, and upwards of ten million tons in 1911, showing an increase of 66·55 per cent. and 74·0 per cent. respectively.

The large number of manufactories of various kinds at Le Havre contributes greatly to its prosperity. The total quantity of coal imported here is estimated at between eight and nine hundred thousand tons annually.

In 1909 the total quantity of merchandise imported and exported and the value of the trade at this port were :—

	Tons.	Francs.	
Imports .	2,221,962	1,502,100,000 =	£60,084,000
Exports .	876,606	1,287,000,000 =	£51,480,000
Totals .	3,098,568	2,789,100,000 =	£111,564,000

The value of the imports to Le Havre by sea constitute about 29 per cent. of that for the whole of France.

The revenue of the Custom House at this port in 1909 amounted to 80 million francs (£320,000), or 38 per cent. of the total from that source in France.

Le Havre may be termed the Liverpool of France. Only 141 miles from Paris, it is a convenient port for the great French steamship companies, such as the Compagnie Générale Transatlantique, who make it the starting-place for New York, etc. It is also the great market for cotton in France, 182,975 tons of which were imported from America in 1910, as compared with 276,759 tons for the whole of France. This port is also the principal market for coffee, importing 127,659 tons, out of a total of 165,055 tons for the whole of France.

Amongst some of the articles imported may be mentioned cacao, 51,216 tons, as compared with 61,015 tons (total imports to France); india-rubber, 11,109 tons, out of 19,977 tons; and copper, 65,295 tons, out of 98,469 tons.

The average value of a ton of merchandise at the five principal ports in 1909 was as follows :—

Le Havre . . .	676 francs	= £27 0 10	per ton.
Marseilles . .	391 ,,	= £15 12 10	,,
Dunkerque . .	413 ,,	= £16 10 5	,,
Bordeaux . . .	171 ,,	= £6 16 10	,,
Rouen . . .	77 ,,	= £3 1 8	,,

The French flag figures for about 33 per cent., as regards tonnage (registered) in the movement of shipping at this port.

The total number of the passengers carried in 1911 by the cross-Channel steamers of the London and South-Western Railway Company was 50,544, of whom 24,482 were landed at Havre, and 20,062 at Southampton.

The passenger traffic between Havre and New York last year shows a decrease of 12,610, as compared with the number carried in 1910. The number carried in 1911 was 60,530, being 21,662 cabin passengers and 38,868 emigrants.

The number of passengers from New York landed at Le Havre during the same period was 42,606, of whom 30,513 were third-class.

Quay accommodation for liners of 300 metres (984 feet) will shortly be completed.

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The works for the improvement of this port, which were sanctioned in 1895, are being pushed rapidly forward, and are expected to be completed in about two years' time.

The new entrance, giving access from the outer harbour to the inner basin, which was opened a few months ago, is working satisfactorily. Ships requiring to enter this basin are no longer detained outside on account of the tide, as was formerly the case.

FISH-CULTURE ON A SMALL SCALE.

It is the opinion of some competent authorities on pisciculture in France, that the rearing of fish on a small scale might prove a profitable occupation if conducted on systematic principles. Many persons are inclined to imagine that this industry can be only carried on successfully in rivers, streams, or lakes. Fish-culture, like bee-keeping, and many other rural industries, may be practised to advantage even where such conditions do not obtain, and prove, in the hands of the small farmer or landowner, a source of profit and interest.

The supply of water for a small establishment need not be greater than that required for a small fountain, with a comparatively small inflow and outflow, such as is so frequently found in the gardens of country houses. Fish can be reared more profitably in small tanks than is the case where the young fry are turned out into a river or lake to shift for themselves, and where it is impossible to protect them from their many natural enemies, as well as from poachers. Where fish are reared on the "intensive" plan, that is to say, in small tanks and artificially fed, it is of the highest importance to breed only those kinds which fetch the highest prices in the market. For this reason the *Salmonidæ*, or fish of the salmon family, which includes the trout and char, are preferable to carp, tench, eels, and other coarse fish, which are better suited for rivers or ponds. The former always find a ready market in all large towns, at prices ranging from 4 francs to 5 francs per kilog. (1*s*. 6*d*. to 2*s*. per lb.), whilst the latter seldom are worth more than 1 franc to 2 francs per kilog. (4½*d*. to 9*d*. per lb.). During the close season as much as 10 francs per kilog. (4*s*. per lb.) is sometimes paid for trout in Paris.

The most suitable fish for small intensive culture are, without doubt, the rainbow trout of California (*Salmo irideus*) and the North American brook trout (*Salvelinus fontinalis*), which is really a char. Both these fish have been acclimatised in Europe. The common migratory trout (*Salmo fario*) of our European rivers does not adapt itself so well to captivity as its American kindred, which, with artificial feeding, grow very rapidly.

The American brook trout (*Salvelinus fontinalis*) appears to be particularly suitable for intensive culture, growing with great rapidity. A specimen taken out of the water, weighing 100 grammes (3½ ozs.), on January 1st last year, and weighed again five months later, had increased to 300 grammes (10½ ozs.), or three times its original weight.

The rainbow trout, as well as the brook trout, thrives better in colder water than other varieties of fish, such as the carp or tench. The temperature of the tanks ought never to be allowed to exceed 64° or 65° F. The tanks in which the fish are kept require to be well shaded, and may be established in some empty barn or suitable outhouse. The size is immaterial, but it has been found that long, narrow tanks, from 20 ft. to 30 ft. long, by 3 ft. wide and 3 ft. deep, are the most manageable size. They should be built of concrete, in pairs, above ground, so as to facilitate drainage. They should communicate with each other by a cross channel, provided with a suitable sluice. The sides and bottoms require to be well rendered with cement, in order to obtain a very smooth surface. Scrupulous cleanliness is essential in fish-culture to ensure success.

The fish require feeding three or four times a day, with slaughterhouse refuse, chopped meat, horseflesh, etc.

It is found in France that fish of about a year's growth, weighing about 100 grammes each (3½ ozs.), are the most marketable size, and this is the most profitable size to the breeder, for beyond that weight they consume, in proportion, a far greater quantity of food than the smaller fish.

OBITUARY.

Sir Raymond West, K.C.I.E.—Sir Raymond West died at his house at Norwood on the 9th inst. He was born in 1832, and joined the Indian Civil Service in 1856 as one of the first batch of successful candidates after the Service had been thrown open to competition. After holding various judicial appointments, he became, in 1871, Judge of the High Court, Bombay, and in 1887 a member of the Bombay Government. In 1892 he retired. He attained a high reputation as a jurist, and introduced many important judicial reforms. While still a member of the Indian Civil Service, he held for a time the office of Procureur-General in Egypt, and produced a valuable report, although the recommendations were of too drastic a character to be immediately adopted. After his retirement he was Reader on Indian Law to the University of Cambridge, and he held this post for fourteen years. He was knighted in 1877.

Sir Raymond became a member of the Royal Society of Arts in 1892, and has served on the committee of the Indian Section since 1893. In the year following his election (1893) he read a paper on "Agrarian Legislation for the Dekhan and its Results." He was a very frequent attendant at the meetings of the Section, and constantly took part in the discussions, the last time when he spoke here being in the discussion on Mr. Yusuf

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Ali's paper on "Indian Mohammedans," in December, 1906.

SIR ROBERT PULLAR, LL.D.—Sir Robert Pullar, an old member of the Society, which he joined in 1876, died on the 9th inst. at Perth. He had for a long time been the senior partner of the well-known firm of dyers at Perth, which had been started by Sir Robert's father about 1824. It is stated in the obituary notice which appeared in the *Times* that when Dr. Perkin produced a coal-tar dye, its practical use was first demonstrated by the inventor at the Perth works in 1856. Sir Robert Pullar represented Perth from 1907 to 1910, although he was nearly eighty when he entered Parliament. He took a great interest in public affairs, and it was his services to Perth, and to charitable, philanthropic, and educational institutions in various parts of Scotland that gained him his knighthood in 1898. He was born in 1828.

NOTES ON BOOKS.

COMMERCIAL GUIDE TO THE FOREST ECONOMIC PRODUCTS OF INDIA. By R. S. Pearson, F.L.S., Economist at the Forest Research Institute, Dehra Dun; Imperial Forest Service, India; Superintendent Government Printing Office, Calcutta. Rupee 1, or 1*s.* 6*d.*

The British Government of India is one of the three most scientifically, and ably, and honestly administered in the world, the other two being those of France and Germany; and, excepting in its Educational Department, it is absolutely the most benevolently administered, even before that of France; while in no other sphere of its imperial authority and responsibilities, unless it be the Judicial, have the results of its benignant operations become so rapidly and tangibly apparent as in the Forest Department. The fact is that, owing to the destructive ravages of the Afghan invaders of Hindustan, and of the maraudings of the Mahrattas in the Deccan, and the direful depredations of the Pindharis, followed up as these were by the scarcely less desolating system of *Kumari* cultivation [that is clearing large forest spaces and burning out the trees on them, just for a year's cultivation of grain, or other staple food, and then passing on to make another clearing for the following year], India would by this time have been reduced to the same desert condition as Persia, but for the gradual settlement of the whole peninsula, between 1757 and 1857, under the paramount power of "the British Raj." Roxburgh and Wallich in Bengal were the first to draw attention to the condition of the forests of Hindustan; emulated later by Alexander Gibson in Bombay, and Henry Valentine Conolly and General Michael in Madras, and Dalzell in Sindh; but it was not until the British Association was led to take the matter up in 1850 and 1851, that forest conservancy was officially organised throughout India, and extended into Burmah; where fortunately the forests continue to flourish to the present day in something of their primeval luxuriance and grandeur. It remains to be seen to what extent the restoration of the forests of Sindh, and of Rajputana, and the Doab [the country between the "Two-waters" of the Jamna and Ganges—compare Mesopotamia], may, during the next one hundred years, affect the climate of Western and North-Western India; for "the South-West Monsoon" is markedly regulated in its date and volume by the stupendous updraught of hot air from the burning surface of these arid regions, sucking up the moisture evaporated from the Arabian Sea and pouring it down in rain over all the Bombay Presidency, and in a lesser measure on Central India and Rajputana, with occasional sprinkles over Sindh. But apart from untoward consequences, due to possible derangements of the mechanism of the South-West Monsoon, as it has been known to us from 1000 B.C., only good can result to India, in an incalculable development of its commercial natural products, by the widest possible extension of the forest area of the country. The total area of reserved and unreserved forests in India and British Burma, including the Andamans, is 243,539 square miles; of which 132,509, or over one-half, has to be credited to British Burma; and as the area of Burma is, roughly speaking, less than one-third that of India, we may judge at a glance how greatly the latter country suffered from the depredations of its secular conquerors from the North-West, out of Central Asia, until the British occupation of India finally put a stop to them. The perennial trade between the East and West had its first start,—all its fresh springs,—in the export of the commercial products of the forests, to which were later added those of the fields, and the rural looms, of India; and this trade was from the first so great and profitable that it made the greatness of all the countries through which in ancient times it took its overland course, whether through the Persian Gulf and Chaldæa, and Assyria, and Babylonia, or through the Red Sea and Egypt;—the Phœnicians first, and, after them, the Greeks, acting as its carriers among all the countries of the Mediterranean Sea. The breaking up of these routes by the Arabs and Mongols made the fame of Venice and Genoa; and on their temporary ruin, by the discovery of the open ocean high road to the East round the Cape of Good Hope, the monopoly of the trade with India, and Farther India, and the Indian Archipelago, and "Higher India" [China and Japan] fell in succession into the hands of the Portuguese, the Dutch, and the English. It was because the Dutch raised the price of pepper against us that we formed, in the reign of Queen Elizabeth, our first East India Company; and the first dredge of English-borne pepper from the East was as the womb of the birth of our whole Indian Empire in the consolidated form it took during the reign of Queen Victoria. But on Ferdinand de Lesseps opening the Suez Canal, which we had all

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along bitterly opposed, Italy was the first to profit by the reopening of the Overland Route to India through Egypt; until to-day both Venice, "throned on her hundred isles," and Genoa bid fair to recover their mediæval commercial glories; and Egypt more than its ancient position of commercial and political command between the Mediterranean and the Red Seas. The advantage of France, by whom it is gradually being seized, is in her having a frontage both on the Mediterranean and on the Atlantic; for, fundamentally, the nations are but so many shops, and oceans and rivers the highways and byways of their traffics: and unless they are doing a good business as shopkeepers, their armies, and navies, and diplomacies, all their seeming power and pomp, are but vanity of vanities. It is difficult to overestimate the antiquity of the trade in the commercial products of the forests, and fields, and gardens of India, and Burma, "the Earth's Green End" of Homer. Weber placed it at 1600 B.C. It would seem to have been regularly organised by 1000 B.C.; and it is certain that from the most ancient historical times the people of India themselves, in co-operation with the Sabæans and Minæans of Arabia, took a part in its development. The name of the island of Socotra is said to be Sanskrit; and the Greek for tin, which gives its name to the Cassiterides, or "Tin [export] islands" off the coast of Cornwall is Sanskrit; and our word "sugar" is unmodified Sanskrit. The Havilah of Genesis ii. 11-12, may not mean India [although I am, myself, convinced it does], but "bdellium" [*bdolach*], mentioned as one of the products of Havilah, whether it refers to bdellium, or to musk, is, in either case, an Indian product; and the word itself is the Sanskrit *madalaka*, the μαδελκον, and μαλαχη of the Greeks, and *mukul* of the Hindus of to-day, and *molochil* and *mukul* of the Arabs. The actual name of India occurs in Esther i. 1, and viii. 9, in the Hebrew form of *Hoddu*, in Syriac *Hendu*, and in Arabic *Hind;* and where, in ch. i. 6, of our "Authorised Version," the Bible, has "white, green, and blue curtains," it should read "white and blue (striped) cotton curtains," that is the cheap cotton rugs made all over India, and used also as "beds" and hangings; —the Hebrew word translated [A.V.] "green" being *Karpas*, which is simply the Sanskrit *Karpasa*, cotton, an aboriginal Indian forest and agricultural product. The Hebrew *sadin* for (calico) "sheets," "fine linen," etc. [Judges xiv. 12-13, Proverbs xxxi. 24, and Isaiah iii. 23], and the Greek σινδων, represent the most ancient Sanskrit name of India [first applied to the valley of the Indus], Sindhu; which in Persian and Arabic became, Hindu, and Hind; and in Greek and Roman India. And so on, and so on, with a hundred Indian mineral, and vegetable, and animal products that have been renowned throughout Europe from the times of Homer, and Hippocrates, and Herodotus, and Pliny, and Dioscorides, and Athenæus;—as fully set forth by me in the "Handbook to the British Indian Section of the Paris Universal Exhibition of 1878."

As to the uses to which timbers and subsidiary forest products, such as tans, dyes, drugs, etc., etc., can be put, exhaustive information is given in Gamble's "Manual of Indian Timbers," Sir Dietrich Brandis's "Forest Trees of North Western and Central India," and in Sir George Watts's colossal work on "The Commercial Products of India"; but the special purpose of Mr. Pearson's present report—and it has been perfectly fulfilled—is to give all that is known of these major and minor Indian forest products in a form, and with the particular details, required by English manufacturers, and the general dealers in, and the importers of, these economic articles; and this is thoroughly well done in 171 pages, divided into three chapters.

The first chapter, after a page or two on the institution of Forest Conservancy by the Government of India, and the distribution of the forest areas of India and Burma, treats of the different types of Indian forests, the Deodar ["God's tree," *cf.* Numbers xxiv. 6] Forests of the Himalayas, the Bamboo Forests of Arakan, the *Acacia arabica* Forests of Sindh, Rajputana, Gujarat, and Central India; the Teak Forests of Bombay, the Evergreen Forests [of Strychnine, and Mango trees, etc.] of the Malabar Coast, the Catechu Forests of the Canara Country, the Tidal Forests [of Mangroves] at the deltas of all the greater rivers of peninsular India, etc., sixteen types in all; the annual output of the whole amounting, in 1907-08, to 4,699,642 tons, of the value of Rs. 26,000,000. It is worth mentioning here how I observed in the Strychnine districts about Bombay, that the Indian children who eat of its divinely painted fruit, swallowed "the stones" with it, without any sort of injury to themselves, —to which fact every road side along my way bore indisputable evidence. The Hornbills, apparently, crunched the seeds up before swallowing them!

The second chapter gives the fullest economic information of eighty of the chief forest trees of India, their timbers, and their subsidiary products; and tells you, in each instance, where inquiries should be made regarding them.

The third chapter is concerned wholly with the minor forest products; such as (1) fibres and leaves, and basts and flosses [such as the silky *Kapock* of *Cochlospermum Gossypium*, the Silk-Cotton Tree, and of the herbaceous shrub *Calotropis gigantea*]; (2) grasses for fibres, and thatchings, and grazing; (3) distillation products, such as *rosha* oil, lemon-grass oil, sandal-wood oil, *Agar-Agar* oil, Cinnamon oil, "*Mohwa* liquor," etc.; (4) oil seeds; (5) dyes and tans; (6) gums and resin; (7) rubber; (8) drugs and spices; (9) fruits and edible seeds; (10) "bamboos" and canes; (11) animal products, such as lac, wax, honey, etc.; and (12) mineral products: and the volume closes with two most helpful indexes, one of the scientific botanical names of trees, shrubs, and other plants mentioned

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in it, and the other of their vernacular names, with the equivalent scientific names, opposite them.

It is needless to say that a book of this character by Mr. Pearson, and bearing the imprimatur of the Government of India, is beyond all praise by me. It has no sins of commission, and its only sin of omission is probably to its official credit. He avoids all reference to the ancient history of the commercial products with which he deals; but the highest interest in them is not in their sordid utility to ourselves, but in their having been known and useful to Babylon, and Nineveh, and Egypt, and Israel, and Greece, and Rome; this fact, as I have personally observed, tending to arouse even in the hard-headed industrial and commercial dealers in them a nobler fervour in their own specialised avocations; and surely the Government likewise would directly gain if, in the preparation of such publications, they made them attractive also to the student of Indian history, and even to the general reader. The neglect of the historical method, moreover, often does the most painful injustice, quite unintentionally, to the men who have gone before us in the field of our own labours. Thus, in his first chapter, Mr. Pearson writes:—"The first serious attempts to increase the area [in the Madras Presidency] under teak were made some eighty years ago by a Civilian, *of the name of Conolly*";—[the italics are mine own!]. Now this was Henry Valentine Conolly, of the Madras Civil Service, and a "Member of Council," Madras, one of the pioneers of forest conservancy in India, assassinated by the Moplas in 1855; and the eldest of four brothers, all of whose names are as household words among Anglo-Indians of the days of the Honourable East India Company; the three others being Arthur Conolly, of the Bengal Cavalry, the author of a work in two volumes [London, 1834] on his overland journey through Persia and Afghanistan to India, and murdered along with Stoddart in prison at Bokhara, 1841–2; Edward Conolly, of the Bengal Cavalry, Commandant of Macnaughten's escort at Cabul, and killed at Purwan Durrah, fighting under Sale in 1840; and Captain John Conolly, killed at the capture of Cabul, 1842. All four brothers died violent deaths in the service of their country; and yet the most distinguished of them all, and one of the founders of the Indian Forest Department, is written of in Mr. Pearson's Report as:—"a Civilian of the name of Conolly." But the fault of it is in no way that of Mr. Pearson, but of the system under which such official works are devised, determined, and done: and except for this default Mr. Pearson and the Government of India alike are to be most gratefully congratulated for this "Commercial Guide to the Forest Economic Products of India." I have dwelt on the default simply because the full, the overflowing recognition of the services of our predecessors in science, art and literature, is of the very foundation of personal, and commercial, and national "culture."

George Birdwood.

GENERAL NOTES.

The Use of Motor-power for Fishing-boats in Japan.—Since the Japanese deep-sea fishing encouragement law was enacted (1910), motor-power has been employed to a great extent for fishing-boats. There are at present about six hundred fishing-boats worked by motor-power and forty-one trawl steamers. Trawl fishing, which was not introduced into Japan until 1907, has been especially successful, and it is thought that in a short time there will be eighty of these boats engaged in the fishing industry on the coasts. Several trawlers are being built at the Osaka Iron Works and other yards, while some have been recently purchased in England at an estimated cost, according to the American Consul at Kobe, of £6,000 each. These steamers are beam trawlers, they run about 150 tons gross, and are built in the same general style, size, and fittings as the trawlers used on the east coast of England. Their fittings, such as winches, many of their nets, and other gear are imported from England, while the boilers and engines are constructed in Japan. The boats are manned by from forty to sixty men, according to their size. They return a profit of ten to twenty per cent. per annum on the investment, as there is always a large market for fish in Japan, the Japanese being great fish eaters. The annual value of fish supplied by the Kobe fish market is given as £300,000, while the fish supplied to Kioto and the neighbourhood from the Kobe market is valued at £150,000. This does not include Osaka, a city of 1,250,000 inhabitants. All edible fish, such as codfish, tai, sea-trout, sole, and many others, are selected for the market, while the non-edible varieties are used for fertilisers after the oil is extracted. Where trawlers work, the bottom must be free from rock and large boulders, otherwise the damage to the nets and gear would diminish the profit considerably.

The Preparation of Bitter Oranges in Valencia.—The oranges canned in Valencia for use in the manufacture of marmalade are exclusively the bitter oranges grown in that district, supplemented occasionally by supplies of the same variety brought from Seville. The operation of canning is as follows, each of the steps being performed by a different set of workers. The oranges are immersed in hot water for a few moments and cleaned with a stiff brush; they are cut in half perpendicularly to their axes; the interior is scooped out of the skins with a chisel-shaped wooden implement some eight or ten inches long by one inch wide. The seeds are then picked from the pulp by hand, and the latter is put in cauldrons where it is boiled by itself for half an hour. It is then passed through a macerating machine, when it is ready to be mixed with the shredded peel and canned. The skins, after the pulp has been removed from them, are placed in a machine which cuts them into long thin shreds.

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These shreds are boiled by themselves for forty-five minutes, when they are ready to be mixed with the pulp and canned. The pulp and shredded peel are canned together in their original proportions—that is to say, the skin of one orange is considered in Valencia the proper amount to balance the pulp of one orange in the finished product, though British preserving houses frequently add extra pulp, which they obtain chiefly from manufacturers of essential oils and flavouring extracts, who use only peel for those purposes. The cans are sealed and then boiled for ten minutes, when the process is complete.

THE CASSAVA INDUSTRY IN JAMAICA.—Cassava, which is also known as "Manioc," a corruption of the name of the genus "Manihot," is cultivated extensively in the West Indies, in South America, and in Africa, where it forms a staple article of diet. In Jamaica cassava ranks third among the "ground provisions," which are the principal articles of food among the natives, yams coming first, and potatoes second. Both kinds of cassava are grown in Jamaica, the sweet cassava (*Manihot aipi*) and the bitter cassava (*Manihot utilissima*) both being prolific bearers of farinaceous tubers, usually eight to ten inches in length and one to three inches in diameter. The tubers of the sweet cassava are eaten as a vegetable, like yams and potatoes. The bitter cassava contains an acrid, poisonous, milky juice, which has to be removed by pressure after the tubers have been washed, scraped, and grated. Bitter cassava is extensively used to make starch for local use and in making "bammies," a sort of cake much used as a substitute for bread in the southern and western parts of the island. Cassava wafers are regarded as a great delicacy by tourists in Jamaica.

MINERAL OUTPUT OF THE UNITED KINGDOM.—According to the report of the Chief Inspector of Mines, just published [Cd. 6340], the total number of persons employed in and about the mines of the United Kingdom in 1911 was 1,096,238, an increase of 18,155 as compared with the figures for 1910. Of the 203,701 surface workers, 6,279, or 3·08 per cent., were females. This is an increase of 58 females as compared with the previous year. The total output of minerals at the mines under the Coal Mines Act was 285,942,232 tons, of which 271,878,124 were coal, 2,482,846 fireclay, 7,886,898 ironstone, 3,116,803 oil-shale, and 577,561 sundry minerals. With the addition of 13,775 tons from open quarries, the total output of coal was 271,891,899 tons, an increase of 7,458,871 tons on the total for 1910, and the greatest output yet recorded.

MATERIALS FOR PAPER-MAKING IN VENEZUELA.—One of the principal articles used in paper-making in Venezuela is the "gamelote" grass (*Panicum myurus*), a broad-leaf grass of very bountiful growth in the tropical sections of Central and South America. In addition to the gamelote used, there are many other grasses, rushes, trees, and plants growing naturally in Venezuela that can be used in the manufacture of paper pulp, among which should be specially mentioned the tree known as the "majagua," or *Paritium tiliaceum*, the wood of which is very much like that of the western cottonwood. This tree is of rapid growth in its usual habitat at an elevation of 2,500 to 4,000 feet, and is easily planted. In Central America it is used a great deal for shade on coffee plantations. It has a broad leaf, but the limbs and leaves are sufficiently far apart to permit the sun to reach the ground beneath, although in such a manner that the rays are broken, and the ground is not baked by them. The inner bark of this tree has a long fibre, which is used in Central America for making rope.

THE TURKISH COTTON INDUSTRY.—The cotton-growing industry of Turkey, which acquired some importance during the American Civil War and declined shortly thereafter, is reviving. In the Cilician Plain, 85,000 bales were produced in 1911. Of these, 50,000 were exported to Austria, Spain, Italy, Germany and France, the estimated value being nearly £450,000. In the Smyrna district 40,000 bales were produced in 1911, of which 28,000 were shipped abroad. Turkey is beginning to manufacture cotton goods, and will require an increasing percentage of its raw cotton for home consumption, while finer, long-fibre qualities may be needed from the United States. Besides spinning-mills at Adana and Tarsus, a British firm has a cloth factory in Smyrna for the manufacture of "cabot" for the Ottoman army. Cotton-growing is expected to make great strides in Turkey, especially in the lowlands of the Jordan, the Tigris, and other rivers emptying into the Mediterranean Sea and the Persian Gulf.

THE AGRICULTURAL PRODUCTS OF THE BELGIAN CONGO.—The wild natural products of the tropical soil have always been a source of great wealth to the Congo. Of these, rubber easily takes the leading place, and millions of rubber trees of different kinds have been planted. The oil palm stands next in importance to rubber from the export standpoint, and is of much greater value to the native population. It furnishes them with food, drink, building material, and wealth. The oils obtained from the fleshy portion of the palm nut and the crushed kernel are exported by tons for soap-making and other purposes. In modern agriculture there has been little progress. Experiments have been made in growing cocoa, coffee, rice, pineapples and maize. The greatest success has been obtained with cocoa, which thrives in the fertile valleys of the Mayumbe. The species of cocoa planted is the "amenolado," from the island of San Thome. As regards pineapples, the "smooth cayenne" variety from the Azores grows well, and can be shipped fresh to Europe in cold storage. An excellent quality of native pineapple grows wild, and is utilised by the missionaries. Bananas, oranges, mangoes, pawpaws, and many other native fruits flourish if given a little care.

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Journal of the Royal Society of Arts.

No. 3,122. VOL. LX.

FRIDAY, SEPTEMBER 20, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE LOOM AND SPINDLE: PAST, PRESENT AND FUTURE.*

By Luther Hooper.

Lecture III.—Delivered March 11th, 1912.

Introduction.

Those of you who have attended the two previous lectures of the course will have realised that my chief aim has been to point out the traditional continuity of the art of weaving, and to show that all real advances in it have been made by bringing new ideas to bear on old principles. This method of advance is common not only to the textile but to all the arts of life. Man, at his best, is not a creator, but an improver, and all attempts to break with tradition and to produce something quite original always must end in more or less grotesque failure.

I have tried to bring this truth out as regards the hand-loom and spindle, and to-night I shall chiefly direct your attention to the same fact, as exemplified in the development of the mechanism of the power-loom during the last century.

The Modern Loom for Plain and Ornamental Weaving and its Future Development.

In the early part of the eighteenth century, weaving, as a handicraft, reached in Europe its point of highest perfection. France, England, and Italy were the chief countries in which it was practised.

At that time, in England particularly, the condition of the textile craftsman, of whatever grade, seems to have been better than at any other period of which we have record.

The weaver of the eighteenth century was a prosperous and respectable tradesman, whether working in the secluded country village, in the suburbs of the great towns of the north and east, or near the metropolis in the pleasant district of Spitalfields—notable as the silk-weaving quarter of London.

This happy condition of the weaver in the eighteenth century declined to one of misery in the nineteenth. The economic causes of this change are not far to seek, but form no part of my subject. I only refer to this period of prosperity, as it marks an important stage and change of direction in the development of the loom.

Hitherto the motive of inventors was to increase the scope and perfection of the loom as a pattern-weaving tool. The perfection attained and the care bestowed on loom construction are shown in the beautiful illustrations of Diderot's Dictionary and other technical works of the period.

During the latter portion of the eighteenth century, and since, the chief purpose of invention has been, not excellence of work and extended capacity of the loom, but economy of time and cheapening of production.

The interesting business of weaving, from the tying-up of the design to the picking and finishing of the woven cloth, which the weaver originally did himself, is now divided up amongst half a dozen "hands," who only do one particular portion of the work, and thus monotonously perform their daily task.

Not only is the weaver's work to a certain extent degraded, but the change from wood to iron for loom construction, and the use of steam as a motive power, as well as the subdivision of labour, have necessitated the grouping of looms in large factories, with all their inconveniences and attendant evils.

This revolution of industry occupied more than a century and a half, and was effected in some branches of the trade sooner than in others. The process is, in fact, in the best branches of silk weaving, still going on.

* A large number of the illustrations are taken from Mr. Hooper's "Hand-Loom Weaving," and are reproduced by the courtesy of the publisher, Mr. John Hogg.

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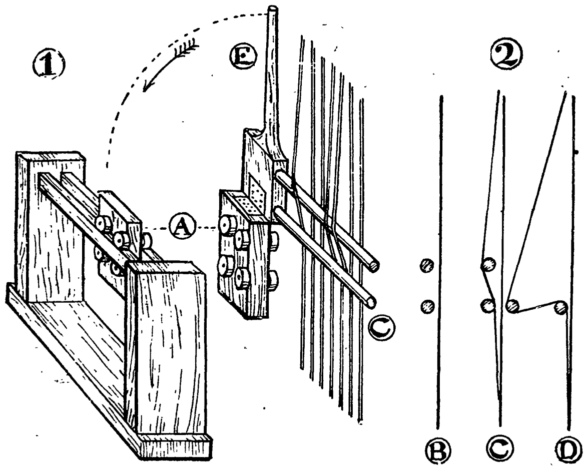

FIG. 46.—DRAW-BOY'S FORK.

The first indication of the coming change in the broad-weaving trade was given as early as 1687, when Joseph Mason patented a machine which he described as "an engine by the help of which a weaver may performe the whole work of weaving such stuffe as the greate weaving trade of Norwich doth now depend on, without the help of a draught-boy, which engine hath been tryed and found out to be of greate use to the said weaving trade."

It is necessary to the understanding of the mechanism of the important machine which superseded it, which I shall presently fully describe, to have a general idea of this draw-boy machine. In order to give this idea, however, I must first describe the work of the human draw-boy. For this purpose we shall need the diagram of the draw-loom used last week (Fig. 44).

[Here the lecturer again briefly repeated his explanation of the various parts of the draw-loom.]

In a rich silk loom there were often as many as two or three thousand lead weights, called *lingoes*, hanging three to each leash of the monture. These weigh altogether a couple of hundredweight. On an average half of them had to be drawn up at every line of the design. Moreover, their *dead weight* would be so increased by the friction of the multitude of cords and pulleys that the boy would have to raise and hold, for several seconds, a weight equal to a hundredweight and a half. This would, of course, be impossible but for some mechanical help. The implement devised for the boy's assistance was called the "draw-boy's fork." This is shown at Fig. 46.

The vertical lines in this diagram represent the cords of the simple.

To the left is a solid stand, having two broad uprights joined together at the top by two parallel bars. A is a block of hard wood, which fits between the bars, and is held in position by four pairs of small wheels. These not only support it but allow it to run freely from end to end of the stand.

This block, with the fork and lever attached, is shown separately at E. The fork and lever are hinged to the block at its top, and can be moved from the vertical to a horizontal position. When about to be used the block is moved till the points of the fork are just beyond the backmost cord of the simple, the lever being in an upright position.

By means of the loops tied to the simple, as shown at Fig. 46, the required cords are drawn forward, and the upper prong of the fork inserted in the opening thus made. Then, grasping the lever, the boy draws it down and holds it. The result of this is that the selected lingoes and leashes are drawn and held up.

At No. 2 three sections of the simple are

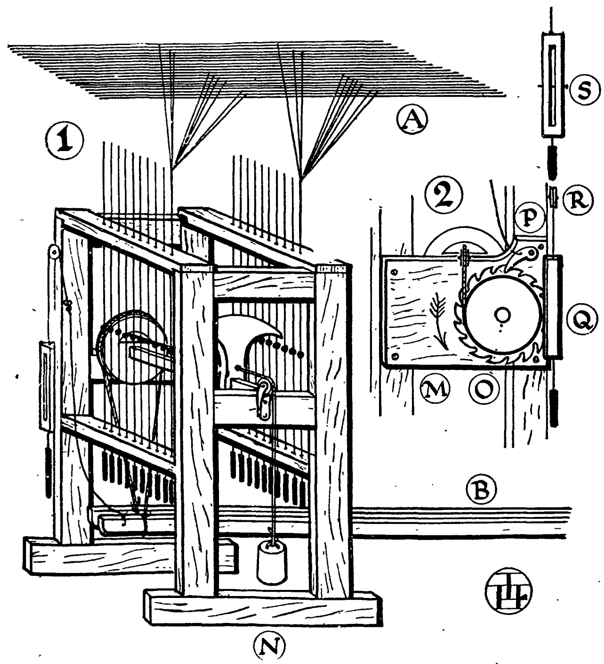

FIG. 47.—THE MECHANICAL DRAW-BOY.

shown, lettered B, C, and D. At B the cords are at rest. At C some cords have been selected and the fork inserted. At D the lever has been pulled over and the cords drawn over with it.

Fig. 47 shows the mechanical draw-boy, a machine invented in the seventeenth century, and improved during the eighteenth. It was attached to the pulley-cords of the loom, on which, when the machine was used, the tie-up of the design was made, instead of on the simple.

The active part of this machine is the pecker, which, by means of two treadles and some little mechanical arrangements, had two movements: (1) it rocked from side to side; (2) it moved, as it rocked, along the machine from one end to the other.

Through holes, in the side cross-pieces of the frame, strong cords terminating in heavy weights, were hung. To the tops of these cords the loops of each row of tie-ups were attached in regular succession. Only two rows are shown connected in the diagram to prevent confusion of lines.

The pecker had a deep notch cut in its points, and was of such a size that, as it rocked, the cord towards which it inclined caught in the notch. At the centre of the cord a large bead was fixed. When the rocking pecker came in contact with this bead it pushed it and its cord down, and held it until the second treadle moved the pecker in the opposite direction.

As the pecker travelled along the shaft each cord was drawn down in its turn, thus opening the shed, line by line, for the working out of the pattern.

The number of lines in the length of a design of course had to correspond with the number of cords in the machine. The draw-boy machine was not, to any great extent, used for the purpose for which it was intended—viz., to supersede the draw-boy of the compound figure weaving loom. I suspect the boy was useful in many ways about the loom, and, moreover, his wages would be no great matter. But late in the eighteenth century, and well into the nineteenth, the machine received a good deal of attention, and was improved and adapted for use with the treadle hand-loom. It enabled the weaver to work any complicated system of heddles, for small pattern fancy weaving, with only two treadles instead of twenty or more.

Fig. 48 is from Porter's Treatise on Silk (1831). It represents an improved draw-boy machine, for which the Society of Arts awarded a prize in 1807. Further improvements were made later, but it was finally superseded by the famous machine which was perfected by Joseph Marie Jacquard, and known in England as the "Jackard" machine.

There can be no doubt that it is to Jacquard that the credit of rendering this machine thoroughly practical is due, although it has been proved that the fundamental idea of it, which consists in substituting for the weaver's tie-up a band of perforated paper, was first applied to the draw-loom in 1725, while in 1728 a chain of cards was substituted for the paper and a perforated cylinder also added.

These early contrivances were placed by the side of the loom and worked by an assistant. In 1745 Vaucanson placed the apparatus at the top of the loom and made the cylinder rotate automatically. But it was reserved for

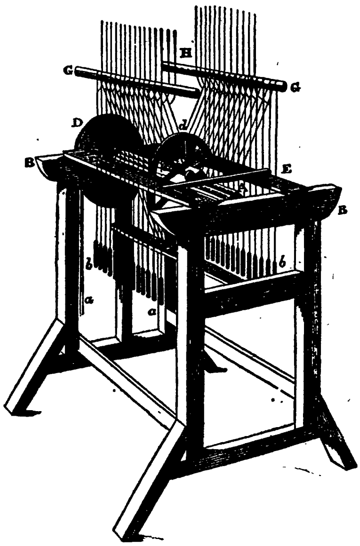

FIG. 48.—THE MECHANICAL DRAW-BOY.
(Early Nineteenth Century.)

Jacquard to carry the machine to such perfection that, although many slight improvements have since been made in it, it remains to-day practically the same as he introduced it in 1801, notwithstanding the astonishing development of textile machinery during the nineteenth century, and the universal adoption of the machine both for hand and power weaving.

Although the invention was introduced to the French public in 1801, it was not till 1820 that a few Jacquard machines were smuggled into England and secretly set up. In spite of much opposition, they soon came into general use, first, and particularly, for hand-looms and silk weaving, but afterwards for power-looms, all kinds of fancy and ornamental webs being, since their adoption, woven by their means.

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May I here repeat and emphasise that the invention of the Jacquard machine did not alter in the least the draw-loom method of pattern

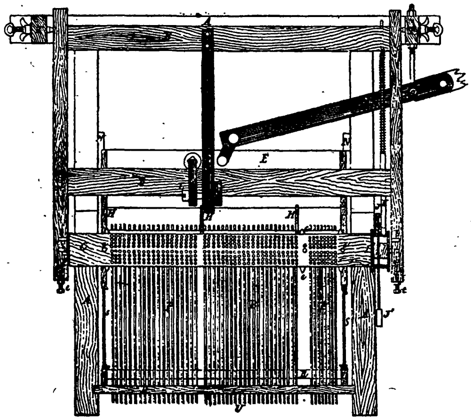

Fig. 49.—Jacquard Machine.
(Front elevation.)

weaving. It only took the place of the draw-boy and the pulley-box; and substituted the endless band of perforated cards for the weaver's tie-up.

The designs, too, draughted on ruled paper, would be worked out in precisely the same manner, whether for tying-up on the cords of a simple, or for punching in a set of Jacquard cards. *Each card, in fact, takes the place of one row of loops of the tie-up.*

The term Jacquard weaving, then, which one so often hears used, is a misnomer. It should be draw-loom weaving with a Jacquard machine, the machine being only an ingenious substitute for a less compact and manageable adjunct of the draw-loom, an adjunct, moreover, which, as we have seen, has continually varied from the time of the invention of this form of loom. After the draw-loom itself, I should class the Jacquard machine as the most important invention in textile mechanism. It therefore claims a careful description.

Fig. 49 is a drawing of the front elevation of a 400 Jacquard machine. The number 400 refers to the number of needles and hooks with which the machine is fitted up. These needles and hooks answer to the number of the simple cords of the draw-loom. A design is still technically spoken of as being draughted for so many cords.

The position of the machine in the loom is at the top, where it is fixed on a solid frame just over the comber board, usually with its end to the front of the loom, so that the elevation shown in the figure is parallel with the side of the loom frame.

The machine frame is oblong in shape. It is made of hard wood for hand-looms and of iron for power-looms. But in either case it needs to be of great strength. To the principal frame a smaller one is hinged at the top, so that it can be raised like a flap.

In this drawing fifty wire hooks are seen standing upright on the bottom board of the machine. The bottom board is perforated with as many holes as there are hooks in the machine, in this case 400. The hooks represented are only one rank, out of eight, which the machine contains. Each hole in the bottom board has a dent or groove cut across the top, in which the bent end of the wire hook rests. This keeps the hook firmly in position, especially when the necking cords of the harness are brought up through the holes and looped on to the wire.

Fig. 50 gives two sections of the machine, one showing it at rest and the other showing it in action. In both sections eight hooks are drawn, one from each rank of fifty.

The hooks have the necking cords attached at the lower ends, and just below the small hook at the top may be seen a set of eight wires, crossing them at right angles. Each of these wires—called needles—is bent into a loop, or eye, where it crosses one of the hooks, and it is because the hook is passed through this eye that it is retained in an upright position. Fig. 51 will show this arrangement quite clearly.

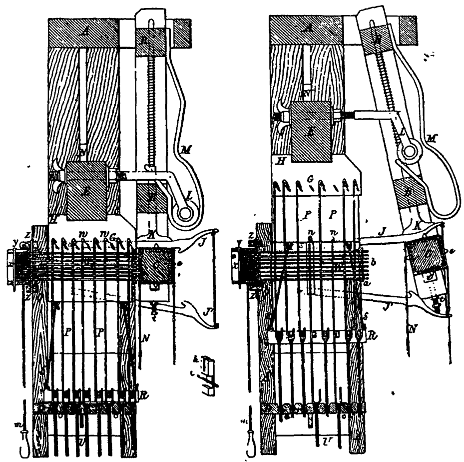

Fig. 50.—Sections of Jacquard Machine.

Each hook thus resting on the bottom board, and held down by the weight of the leashes of the harness, though supported at the top by the eye of the needle, through which it passes,

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is still free to rise and raise with it the leash or leashes to which it is attached.

Leaving the hooks thus standing, let us consider the arrangement for lifting them.

Above the hooks the section of a solid block of heavy wood or iron is shown. This block runs from end to end of the machine, and has projections at its ends which fit into the narrow spaces between the two pairs of uprights of the machine frame in such a manner that the block can be caused to slide up and down steadily but freely.

Now let us look at the block in the drawing of the front elevation (Fig. 49), and then at a drawing showing the block in detail, separately.

The lever for raising the block being extended to a convenient length, is connected by a rope to a treadle worked by the weaver's foot in the hand-loom, or by any ordinary mechanical arrangement in the power-loom.

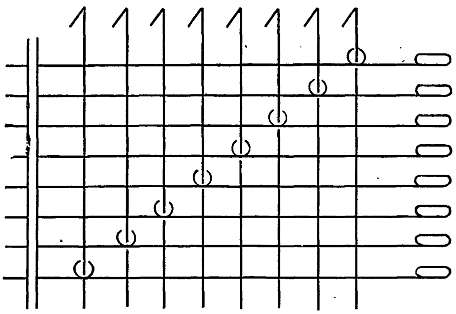

FIG. 51.—DIAGRAM OF HOOKS AND NEEDLES IN A JACQUARD MACHINE.

Fig. 52 gives us details of the block: (1) as seen in front elevation; (2) from above; and (3) from the end.

The block, the lever, and the arrangements for sliding up and down are already explained. But hanging from the block is a kind of gridiron, called by the weaver a "griffe," which requires careful notice. Near each end of the block a flat plate of iron is firmly fixed. The shape of the plate is shown at No. 3, and between the plates, eight bars of hoop iron are fitted, as at No. 2. These bars are placed diagonally (see No. 3), and their top edges are sharpened so as to fit under the carefully-made small hooks at the top ends of the upright wires as they stand in their several rows.

The first section of Fig. 50 shows the block at its lowest position, with the hooks caught on the bars of the griffe. Should the block now be raised, the whole of the 400 hooks will be drawn up and the whole warp will rise with them. When released, of course, all will fall together, pulled down by the lead weights. Again, if the projecting ends of the needles are pushed inwards, the needle eyes will deflect the hooks, and remove them from the griffe, which will then, if the block be raised, rise by itself, leaving the hooks, leashes, and warp all down, as in section 2.

In section 2 the points of the needles are seen to pass through and project beyond the surface of an accurately perforated board fixed to the front of the machine frame opposite the needles. Hung in the frame, hinged to the top of the machine, is a four-sided revolving bar, or cylinder, each side being perforated so as to match exactly the perforations of the needle board.

If the flap, with the cylinder in it, be pressed against the board, and the block raised, nothing different will happen, because the points of the needles will have been free to enter the holes in

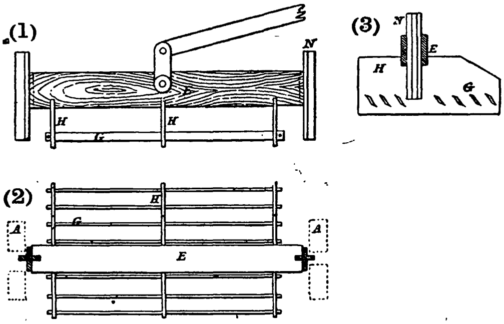

FIG. 52.—DETAILS OF THE BLOCK OF A JACQUARD MACHINE.

the cylinder. If, however, a card covering all the holes be fixed to one side of the cylinder and the cylinder then be brought close up, presenting each side in regular succession, every time the card comes in contact with the needle-points the needles will be pressed inwards, push the hooks off the bars of the griffe, and the block will rise without them.

It follows, then, that if we interpose between the needle-points and the side of the cylinder, as it presses the needle-board, a card perforated according to an arranged design, wherever a hole is covered by the card a needle will be pressed in, and consequently a hook will be pushed off the griffe-bar, and left down as the block rises.

Each card, therefore, affects, in one way or another, every hook in the machine with its necking cords and leashes; and these, of course determine the rising or remaining down of every thread of the warp from edge to edge of the web.

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At the back of the machine a shallow box is fitted, containing four hundred small spiral springs, one for each needle. When, therefore, any needle is pressed inwards by the card on the cylinder, its opposite end is forced into the spring box, but as soon as the pressure is relaxed the needle, driven back by the spring, regains its normal position, holding the hook upright.

The mechanical contrivances by means of which the cylinder is moved, pressed against the needle-board and rotated as the block rises and descends, are most ingenious, and subject to a great deal of variation. They are, however, not essential to the principles of the machine and can be passed over. But the method by which the perforated cards are adjusted to the cylinder and interpose between it and the needle-board must be explained.

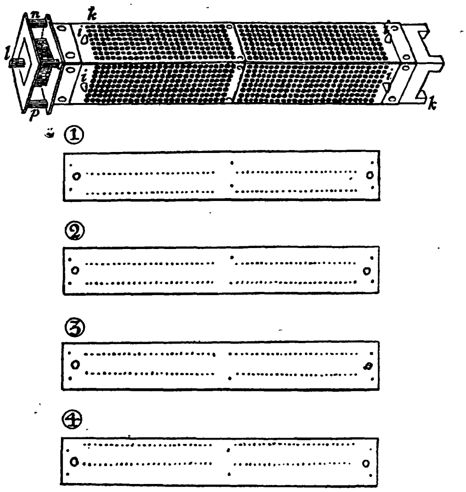

FIG. 53.—JACQUARD CYLINDER AND CARDS.

Fig. 53 shows a detached cylinder and four cards punched with a pattern called a four-lined twill. This pattern repeats on every four lines; accordingly only four cards are needed to weave it. At the ends of the cylinder, close to the perforations, pegs are fixed and holes matching these pegs in size and position are punched in the cards. These pegs hold the card in its proper place, so that its perforations correspond exactly with those of the cylinder.

Each side of the cylinder as it rotates, being covered with a card held close to it by two elastic bands, will press against a different set of needles at each of its four movements. The fifth movement, of course, brings the first set of needles again into play. When, however, as is generally the case, more than four lines of design are required, the cards have to be laced together in an endless band hung upon a rack at the side of the loom, and carried round the cylinder.

The most striking advantage of the use of the Jacquard machine in the textile arts is the facility it gives for a frequent change of design. It is only necessary to take down one set of cards and hang up another in order to change the pattern. The result of this facility was that the early part of the nineteenth century witnessed a perfect orgie of fantastic ornamentation. The manufacturers, of all sorts of ornamental silk and fine woollen textiles, vied with each other in the number and originality of the designs they could produce. The profession of designer may almost be said to be an outcome of the invention of Jacquard. Previously to this time the master weaver, or some person in practical touch with the looms, had arranged the design, and when once tied up on the loom it was good for a lifetime. But with the introduction of the new *draw-engine*, as the machine was called, all this was altered, and restless change of pattern and fashion was the result.

At first the machine was only adopted in the silk trade for the weaving of rich brocades and other elaborate materials for dress or furniture, but ever since its introduction its use has been gradually extending, all kinds of plain and ornamental textiles being now made by its means, whether on hand or power-looms.

As a work of mechanism it is truly wonderful. It can be made to govern all the operations of the loom except throwing the shuttle and actuating the lever by which it itself works. It opens the shed for the pattern, however complicated, regulates the length of the design, changes the shuttle-boxes in proper succession, rings a bell when certain points in a design requiring special treatment are reached, regulates the take-up of the woven cloth on the front roller, and works out many other details, all by means of a few holes punched in a set of cards. Its great defects are the dreadful noise it makes, the ease with which it gets out of order, and the difficulty of putting it right. These render it only suitable for factory use, where noise does not seem to matter, and where a machinist is constantly at hand to keep the mechanism in good order.

So far I have traced the development of the hand-loom, from its most primitive form to one of a high degree of perfection, as a tool for the skilful artificer. Here I must at present leave it, and turn to a brief consideration of the machine-loom actuated by steam or other power.

In order to find the earliest recorded attempt to weave by power, we must carry our imagi-

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nation back to the latter part of the sixteenth century, and look in on the Fathers of the City of Dantzic, in council chamber solemnly assembled. They are deciding the fate of a prisoner accused and found guilty of the crime of inventing a very ingenious machine for weaving narrow tape several breadths at a time.

The council, having carefully considered the machine, and bearing in mind the state of the trade, were "afraid that by this invention a great many workmen might be reduced to beggary." *They, therefore, mercifully ordered the machine to be suppressed, and the inventor of it to be privately strangled or drowned!*

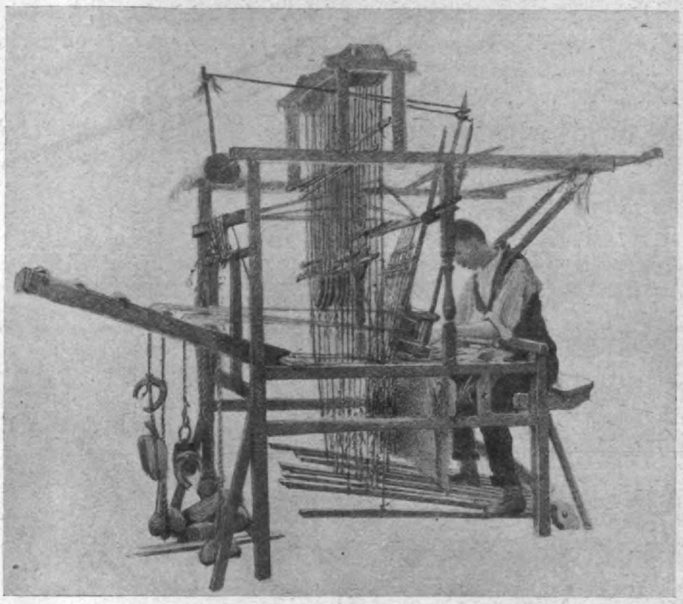

FIG. 54.—NARROW SILK WEAVER AT WORK.
(From a Drawing by the Author.)

The weaving trade has always been divided into two great branches. The broad weavers made stuffs, for garments and furniture, seldom less than twenty-one inches wide. The narrow-branch weavers made ribbons, laces, tapes, braids, galloons, and suchlike goods, and, of course, when these were only woven in single widths on hand-looms vast numbers of persons were employed in weaving them. There was a great demand for such goods in the Middle Ages.

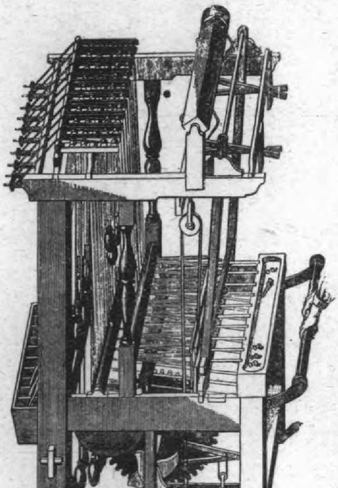

FIG. 55.—DUTCH BAR-LOOM.

Fig. 54 shows a narrow weaver at work on a hand-loom. I discovered him the other day in a small trimming factory near Piccadilly Circus. The loom he is working at is an actual survival of the eighteenth century. There are several others in use at the same factory, where braids and trimmings for high-class furniture are always being made.

Attempts were made at various times in the seventeenth century to introduce the machine tape-loom, but complaints and rioting prevented them succeeding. It was not until the eighteenth century that prohibitions were finally revoked, and the Dutch bar-loom, as it was called, came into general use.

An illustration of this loom is given in the great French mechanical encyclopædia published in 1786. It is reproduced in Fig. 55.

The reason why the ribbon-loom was so readily made workable by power was because it did not require the one movement which has always been the great obstacle in the way of weaving broad webs on machine-looms. That is, the *throw of the shuttle.* Nay, not so much the *throw*, but the *catch* of the shuttle.

Fig. 56 shows the graceful operation on which good weaving depends; an operation

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which has never yet been successfully imitated by machinery, and probably never will be.

The operations of the loom in weaving are four in number: To open the shed, to throw

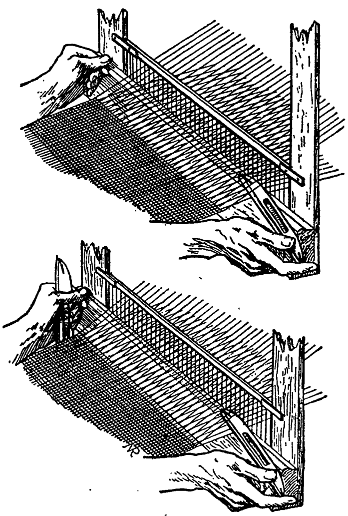

FIG. 56.—HAND SHUTTLING.

and catch the shuttle, to beat the weft together, and to wind up the woven cloth. All these, except the second, are comparatively easy to arrange for, even in broad weaving, by means of a power-driven turning shaft, furnished with cranks and eccentrics, fitted up in some convenient position in the loom. In narrow weaving the spaces of warp are so small that the passing through of the several shuttles presents no difficulty; consequently the invention of a practical automatic machine-loom for narrow weaving was an early one.

Many attempts were made in the seventeenth and early part of the eighteenth century to weave broad webs by power, but they all failed to solve the problem of the shuttle. It has been partially overcome since, but the great defect of the machine-loom to-day is in the driving and catching of the shuttle.

The invention which partially solved the difficulty, and eventually rendered the machine-loom practicable, was the fly-shuttle, intended by John Kay, its inventor, for use on the hand-loom. Its purpose was to enable a weaver to weave, without the aid of an assistant, wider webs than he could manipulate with the hand-shuttle.

Fig. 57 represents the batton used for the fly-shuttle, and should be compared with the hand-shuttle batton (Fig. 30).

The difference between hand-shuttling and fly-shuttling can almost be distinguished by comparing the two shuttles used. The hand-shuttle is slightly curved and adapted nicely to the position of the weaver's fingers. The fly-shuttle, on the contrary, is rigidly straight, so that it flies along in front of the reed, without any bias, from one end of the race to the other.

Comparing the battons, it is seen that the race-block of the fly-shuttle batton is elongated at the ends. On these ends the shuttle can stand clear of the cloth which is being woven, and which is, of course, never wider than the reed.

These elongated ends have a bar of wood so fixed in the front that there is just room for the shuttle to run in and rest between it and the back of the shuttle-box, as the elongated end is called.

Above the shuttle there is a thin, smooth iron bar, and on this the driver (enlarged at F), made of tough leather, is fitted so that it will easily slip from end to end of the box. Both boxes are furnished with drivers and are fitted up in exactly

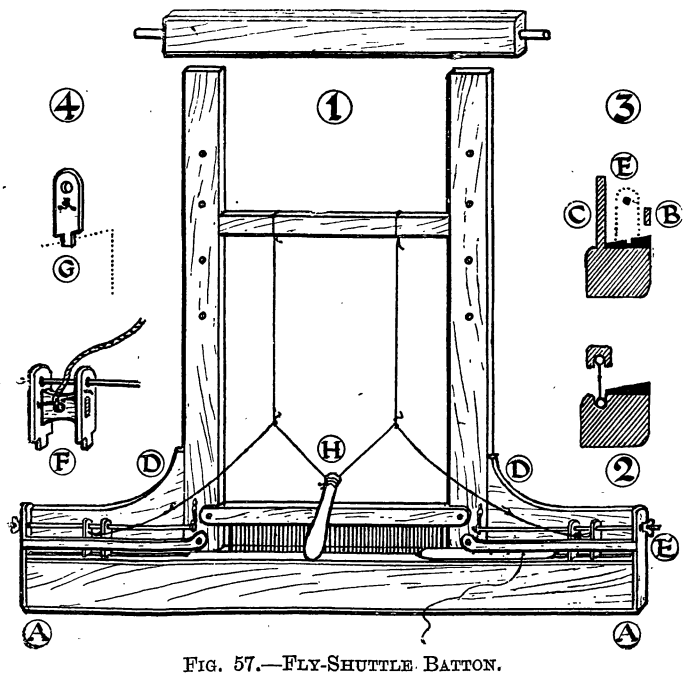

FIG. 57.—FLY-SHUTTLE BATTON.

the same manner. The two drivers are connected by a thin loose cord, having at its centre a handle. The loose cord is suspended from the bar above it merely in order to keep it off the level of the web. To drive the shuttle across the race, the weaver grasps the stick, after placing the shuttle in the box near the driver, and with a sudden jerk, to the side he wishes to send the shuttle, pulls the driver along the bar with just sufficient force to drive the shuttle into the opposite box. By a slight turn of the wrist—which is difficult to acquire and impossible to imitate by a machine—the opposite driver is brought forward to meet the shuttle as it enters the box. If this be properly done, there will not be the least rebound, and the weft will be laid evenly and straight. If, on the contrary, the shuttle be allowed to rebound, the shoot of weft will be loose, and when beaten down by the reed will show kinks and loops. Moreover the edges of the web will be uneven.

Previously to this invention all attempts to pass the weft through the shed, in machine-looms, failed to achieve anything like the speed of the hand-thrown shuttle, consequently they could not compete with the hand-loom. Even when the fly-shuttle method was adopted the difficulty of catching the shuttle baffled the skill of inventors for many years.

The attempts of inventors to produce an automatic broad-weaving machine resulted in the construction of many weird, though ingenious, contrivances bearing more or less likeness to the hand-loom in general use. Many of these were patented by their inventors, but failed to prove practically useful. It was not till 1786, when Dr. Edmund Cartwright devoted himself and his fortune to mechanical invention,

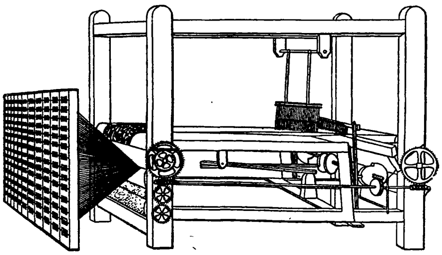

FIG. 58.—DR. CARTWRIGHT'S MACHINE-LOOM.

that a practical broad-weaving power-loom was evolved. Dr. Cartwright established a weaving and spinning factory at Doncaster, but after spending £30,000 and nine years in experiments he was obliged to give it up. He had, however, succeeded in devising a power-loom for plain weaving which it was believed could compete with the hand-loom. Several of his looms were bought by a Manchester firm and set up in a factory. They are said to have

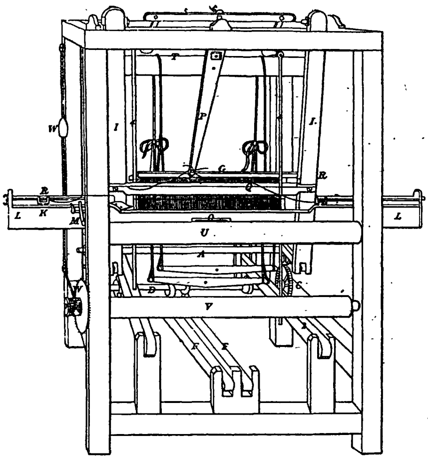

FIG. 59.—HORROCKS'S MACHINE-LOOM.

performed their work well, but the factory was, shortly after its starting, burned down by an infuriated mob of hand-loom weavers.

Fig. 58 is a photograph from one of Dr. Cartwright's designs for a power-loom. A careful examination of it, and its specifications, shows that the doctor had many ideas which were long afterwards adopted by improvers of power-loom machinery.

Fig. 59 is a drawing of a machine-loom constructed by a Mr. Horrocks a little later than Dr. Cartwright's time. It is said to have become largely used. It more closely resembles the fly-shuttle hand-loom than any of the other inventions. I should think it was only capable of weaving very faulty cloth.

By the end of the eighteenth century, it is said, there were 20,000 power-looms at work in Great Britain against 250,000 hand-looms. The power-looms, like the hand-looms, were constructed mostly of wood, and must have been clumsy and uncertain in their performances. Owing, too, to the greater strain of power weaving they must have quickly worn out.

It was a long time before a convenient form for the power-loom was generally adopted. Curiously enough, the form at length settled on was designed for a hand-loom in 1771.

The inventor of this loom (Fig. 60) was a Mr. Almond, who exhibited and worked it before the Society of Arts, and received a prize of £50 for his encouragement. Its chief feature is the inverted batton. It has also extra rollers, by

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means of which the length of the loom is greatly diminished.

A power-loom erected for Mr. Monteith, a Glasgow manufacturer, about the beginning of the nineteenth century by a loom builder named Austin is extremely like Almond's hand-loom.

Mr. Austin presented a model of this loom to the Society of Arts, of which Fig. 61 is a representation.

Having settled on a general form suitable for the power-loom, inventors next directed their attention to strengthening it and perfecting as far as they could, its various parts. Take-up motions, contrivances for detecting broken threads, quickly stopping the loom, throwing the shuttle, etc., occupied their attention, and the loom became more and more accurate in its different performances as time went on.

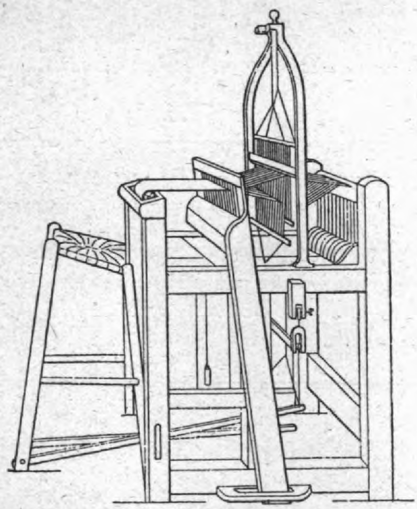

FIG. 60.—ALMOND'S LOOM.

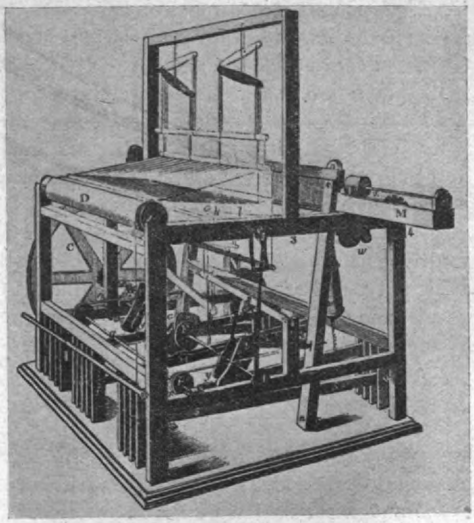

FIG. 61.—AUSTIN'S MACHINE-LOOM.

Iron took the place of wood all through the machine, and the loom, actuated by steam-power, has by now become, except in the matter of working the shuttle, a very perfect automatic machine.

Fig. 62 is a modern steam machine-loom for weaving silk. You will notice at once how the levers for driving the shuttle, and the shuttle-boxes, have increased in size and strength. It was found that, in order to catch the shuttle and prevent it rebounding, its entry into the opposite box had to be resisted. This rendered it necessary that the shuttle itself should be enormously increased in weight, and that great force should be used in driving it. Half the power expended in actuating the machine-loom is required thus to drive the shuttle into the opposite opposing box.

The addition and adaptation of the Jacquard machine to the power-loom was not attempted till late in the nineteenth century, but when that was done the loom had arrived at the point of development at which we find it to-day.

A few months ago my attention was called to an illustration in the *Manchester Guardian* which represented a new weaving invention, and, on reading the description of it, I found that the inventor—Mr. Whalley, of Clitheroe—claimed to have solved the problem of the shuttle, which I have pointed out has been the chief obstacle in the way of weaving by power.

Fig. 63 is a photograph of the new loom which appears to me to be likely to revolutionise

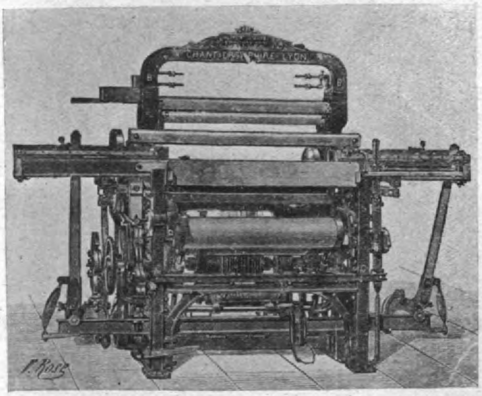

FIG. 62.—MODERN MACHINE-LOOM FOR SILK WEAVING.

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the construction of machines for weaving by power.

Although, at first sight, this loom seems to be altogether different from previous inventions,

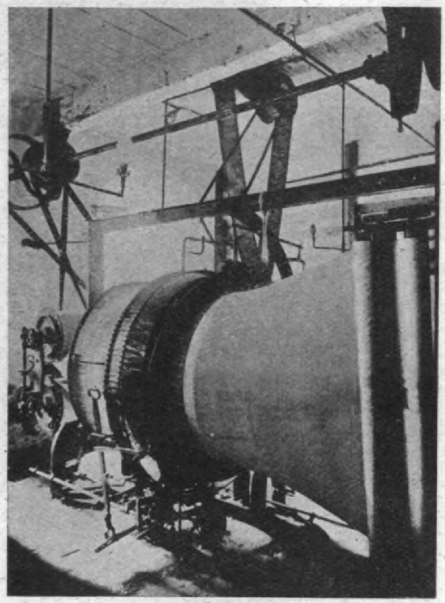

FIG. 63.—WHALLEY'S CIRCULAR MACHINE-LOOM.

an examination of it proves that in most essential points the tradition of weaving, which I have attempted to explain, still governs it. Three great advantages are claimed for it—(1) it is practically noiseless; (2) the weft has no jerk or strain upon it; (3) very little power is required to drive it. In addition to this, webs of between eleven and twelve feet wide are woven on it.

There is not time for me to give an adequate description of this important invention, but I must notice its salient points, and show (1) how it differs from the ordinary power-loom, and (2) how the traditional principles of weaving are still carried on in it.

First, as to points of difference: All the operations of the loom are worked out by its simply turning on its own accurately centred axis.

By an uninterrupted circular movement in one direction the warp is drawn off the warp-beam, the shed is opened and the weft inserted, the weft itself is gently pressed close instead of being beaten together, and the woven web is delivered and rolled on to the cloth beam without any strain or jerk whatever.

There is no shuttle. A case for the flexible cop of wound weft takes its place. The cop itself is of enormous length and holds a hitherto unheard-of quantity of yarn.

While the whole loom and its fittings revolve, the cop case remains stationary, balanced in the shed, and allows the weft to be drawn off it continuously in one direction, as, at each revolution, the successive sheds are opened. This forms, of course, a spiral thread in the woven cloth, the cloth itself being produced in the form of an enormous tube. As the cloth passes on to the cloth beam an automatic knife cuts it at a place where specially woven doup selvages are made.

So far all is new. The rest of the mechanism is an ingenious rearrangement of the traditional parts of a loom. The description of these essential parts requires a diagram of a section of the loom, which we have in Fig. 64.

In the centre of the section is the steel axis, which runs the whole length of the loom.

The perforated comber board, instead of being straight and horizontal, as in the ordinary loom, is circular, and is duplicated, the holes being most accurately pierced.

The holes in these circular comber boards are very close together, and there are as many holes as there are threads of warp.

In each of these holes there is a long steel needle, with its eye in the centre, the needle itself being rather more than twice as long as the space between the two comber boards.

These needles fit loosely into the holes of the

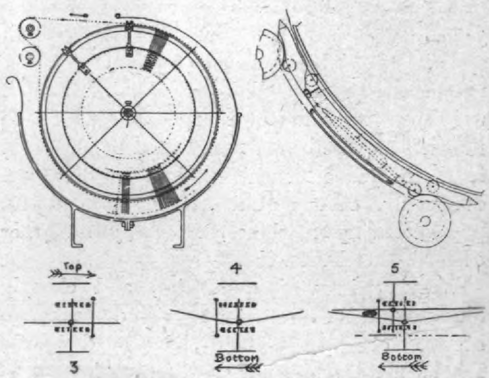

FIG. 64.—SECTION OF WHALLEY'S LOOM.

comber boards, so that when they reach, as the loom revolves, a position above the horizontal centre of the machine they rest against the central core of the loom.

But when in turn the needles come below the horizontal centre they project through the holes

of the outer perforated circle as shown in the drawing.

A thread from the warp-beam is drawn through the eye of each needle, and, when passed through the circular reed and fastened to the cloth beam, will, of course, follow the movement of the needle as it falls against the core at the top or projects through the holes of the outer comber-ring. This is shown at Nos. 3 and 4, which are longitudinal sections.

An endless band of cards, similar to those used for the Jacquard machine, fits to the outer rim and governs the design. Where these cards have holes in them the needles fall through and draw down the warp thread entered in them, but where the card is plain the needle retains its position. This is shown at No. 5, where an open shed is represented.

No. 2 shows the cop of weft in its case in position for working, where it is retained by two smooth bowls of bosses fixed in their places on the stand or under-framework of the loom. The opened shed surrounds the cop case, passes along it, and when it leaves it, it of course encloses the weft.

By an arrangement at the top of the loom the reed is slightly pushed forward, so that it gently presses the weft into its place as it passes a certain point. Very little pressure is sufficient, as only a few inches are affected at a time.

Time forbids me to attempt a description of other details of the circular loom, some of which, no doubt, will be altered and improved. But sufficient has, I hope, been described for the general idea of the machine to be understood, and its great achievement, the continuous wefting contrivance, to be appreciated. Although the hopes of the inventor of this circular loom may not at once be realised, I shall be surprised if the principle on which it works does not eventually become universally adopted for power-weaving machines, especially for plain or small-patterned webs.

Weaving in vast quantities, and cheaply imitating, in inferior materials, rich damasks and brocades of important and elaborate design is, I hold, neither wise nor desirable. The use of machine-looms for this kind of work is, therefore, to be deprecated. The tender manipulation required for weaving the varying textures of the finest webs made in the eighteenth century, and in China and the East generally, is only possible on a loom as sensitive as the perfected draw-loom, and by a craftsman who, understanding every detail of the mechanism, is capable of controlling it. If such perfect work be required, it must be done on a hand-loom.

This loom, however, need not be as cumbrous as the old draw-loom, nor as noisy and intricate as one fitted with the Jacquard machine. If I may don the mantle of the prophet, I should say three things will be retained, and will continue the tradition of the past in the hand-loom of the future. With an indication of these I must conclude my lectures.

1. The skilful manipulation of the hand-shuttle for work not too wide for it, and of the fly-shuttle for broader webs, cannot be improved upon. It will, therefore, be retained.

2. The perforated comber board (Fig. 45), which, as I showed last week, was an ancient Chinese invention, must be retained. Probably, however, some arrangement of metal needles, such as those of the circular loom just described, will be substituted for the string leashes with their mails and lingoes. But all the upper complications of strings and cords will be dispensed with.

3. The principle of working out the design by punching holes in a band of cards will be retained, although the Jacquard machine itself will, I imagine, be superseded by an electro-magnet placed above the comber board. This magnet will attract the metal needles and raise the warp, some arrangement being made so that only those needles wanted for making the required shed will be raised.

Everything else may go, and new contrivances be introduced, but it is on some such hand-loom as this that I can imagine the master-weaver of the future being able, not only to produce webs as exquisite as those of the best weavers of the past, but to carry the art forward to a higher degree of perfection than it has ever yet attained.

HEALTH AND VENTILATION.*

Everyone thinks that he suffers in an ill-ventilated room owing to some change in the chemical quality of the air, be it want of oxygen, or excess of carbon dioxide, the addition of some exhaled organic poison, or the destruction of some subtle property by passage of the air over steam-coils, or other heating or conducting apparatus. We hear of "devitalised" or "dead" air, and of "tinned" or "potted" air of the battleship. The good effects of open-air treatment, sea and

* Extracts from the Presidential Address to the Physiological Section of the British Association, by Leonard Hill, M.B., F.R.S.

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mountain air, are no less generally ascribed to the chemical purity of the air. In reality the health-giving properties are those of temperature, light, movement, and relative moisture of the surrounding atmosphere, and leaving on one side those gross chemical impurities which arise in mines and in some manufacturing processes, and the question of bacterial infection, the alterations in chemical composition of the air in buildings where people crowd together and suffer from the effects of ill-ventilation have nothing to do with the causation of these effects.

Satisfied with the maintenance of a specious standard of chemical purity, the public has acquiesced in the elevation of sky-scrapers and the sinking of cavernous places of business. Many have thus become cave-dwellers, confined for most of their waking and sleeping hours in windless places, artificially lit, monotonously warmed. The sun is cut off by the shadow of tall buildings and by smoke—the sun, the energiser of the world, the giver of all things which bring joy to the heart of man, the fitting object of worship of our forefathers.

The ventilating and heating engineer hitherto has followed a great illusion in thinking that the main objects to be attained in our dwellings and places of business are chemical purity of the air and a uniform draughtless summer temperature.

Life is the reaction of the living substance to the ceaseless play of the environment. Biotic energy arises from the transformation of those other forms of energy—heat, light, sound, etc.—which beat upon the transformer—the living substance. Thus, when all the avenues of sense are closed, the central nervous system is no longer aroused and consciousness lapses. Laura Bridgeman, paralysed in almost all her avenues of sense, fell asleep whenever her remaining eye was closed. The patient who lost one labyrinth by disease and, to escape unendurable vertigo, had the other removed by operation, was quite unable to guide his movements or realise his position in the dark. Rising from bed one night, he collapsed on the floor and remained there helpless till succour arrived.

A sense organ is not stimulated unless there is a change of rate in the transference of energy; and this to be effectual must occur in most cases with considerable quickness. If a weak agent is to stimulate, its application must be abrupt. Thus the slow changes of barometric pressure on the body-surface originate no skin sensations, though such changes of pressure, if applied suddenly, are much above the threshold value for touch. A touch excited by constant mechanical pressure of slight intensity fades quickly below the threshold of sensation. Thus the almost unbearable discomfort which a child feels on putting on for the first time a "natural" wool vest fades away, and is no longer noticed with continual wear. Thomas à Becket soon must have become oblivious to his hair-shirt, and even to its harbingers. It is not the wind which God tempers to the shorn lamb, but the skin of the lamb to the wind. The inflow of sensations keeps us active and alive, and all the organs working in their appointed functions. The cutaneous sensations are of the highest importance. The salt and sand of wind-driven sea air particularly act on the skin and through it braces the whole body. The changing play of wind, of light, cold, and warmth, stimulate the activity and health of mind and body. Monotony of sedentary occupation and of an overwarm still atmosphere endured for long working hours destroys vigour and happiness, and brings about the atrophy of disuse. We hear a great deal of the degeneration of the race brought about by city life, but observation shows us that a drayman, navvy, or policeman can live in London, or other big city, strong and vigorous, and no less so than in the country. The brain-worker, too, can keep himself perfectly fit if his hours of sedentary employment are not too long and he balances these by open-air exercise. The horses stabled, worked, and fed in London are as fine as any in the world; they do not live in windless rooms heated by radiators.

The hardy men of the North were evolved to stand the vagaries of climate—cold and warmth—a starved or full belly have been their changing lot. The full belly and the warm sun have expanded them in lazy comfort; the cold and the starvation have braced them to action. Modern civilisation has withdrawn many of us from the struggle with the rigours of Nature; we seek for and mostly obtain the comfort of a full belly and expand all the time in the warm atmosphere afforded us by clothes, wind-protected dwellings, and artificial heat—particularly so in the winter, when the health of the business man deteriorates. Cold is not comfortable, neither is hunger, therefore we are led to ascribe many of our ills to exposure to cold, and seek to make ourselves strong by what is termed good living. I maintain that the bracing effect of cold is of supreme importance to health and happiness, that we become soft and flabby, and less resistant to the attacks of infecting bacteria in the winter, not because of the cold but because of our excessive precautions to preserve ourselves from cold; that the prime cause of "cold" or "chill" is not really exposure to cold but to the over-heated and confined air of rooms, factories, and meeting-places. Seven hundred and eleven survivors were saved from the "Titanic" after hours of exposure to cold. Many were insufficiently clad and others wet to the skin. Only one died after reaching the "Carpathia," and he three hours after being picked up. Those who died perished from actual cooling of the body. Exposure to cold did not cause in the survivors the diseases commonly attributed to cold.

The conditions of great cities tend to confine the worker in the office all day, and to the heated atmosphere of club, cinema show, or music-hall in the evening. The height of houses prevents the town dweller from being blown upon by the wind, and, missing the exhilarating stimulus of the

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cool, moving air, he repels the dull uniformity of existence by tobacco and by alcohol, or by indulgence in food, *e.g.*, sweets, which are everywhere to his hand, and by the nervous excitement of business and amusement. He works, he eats, and is amused in warm, windless atmospheres, and suffers from a feeble circulation, a shallow respiration, a disordered digestion, and a slow rate of metabolism.

Experimental evidence is strongly in favour of my argument that the chemical purity of the air is of no importance. Analyses show that the oxygen in the worst-ventilated school-room, chapel, or theatre is never lessened by more than 1 per cent. of an atmosphere; the ventilation through chink and cranny, chimney, door, and window, and the porous brick wall, suffices to prevent a greater diminution. So long as there is present a partial pressure of oxygen sufficient to change the hæmoglobin of the venous blood into oxyhæmoglobin, there can arise no lack of oxygen.

At sea-level the pressure of oxygen in the pulmonary alveolar air is about 100 mm. Hg. Exposed to only half this pressure the hæmoglobin is more than 80 per cent. saturated with oxygen.

In noted health-resorts of the Swiss mountains the barometer stands at such a height that the concentration of oxygen is far less than in the more ventilated room. On the high plateau of the Andes there are great cities: Potosi with a hundred thousand inhabitants is at 4,165 metres, and the partial pressure of oxygen there is about 13 per cent. of an atmosphere in place of 71 per cent. at sea-level; railways and mines have been worked up to altitudes of 14,000 to 15,000 feet. At Potosi girls dance half the night, and toreadors display their skill in the ring. On the slopes of the Himalayas shepherds take their flocks to altitudes of 18,000 feet. No disturbance is felt by the inhabitants or those who reach these great altitudes slowly and by easy stages. The only disability to a normal man is diminished power for severe exertion, but a greater risk arises from want of oxygen to cases of heart disease, pneumonia, and in chloroform anæsthesia at these high altitudes. The newcomer who is carried by the railway in a few hours to the top of Pike's Peak or the Andes may suffer severely from mountain sickness, especially on exertion, and the cause of this is want of oxygen. Acclimatisation is brought about in a few days' time. The pulmonary ventilation increases, the bronchial tubes dilate, the circulation becomes more rapid. The increased pulmonary ventilation lowers the partial pressure of carbon dioxide in the blood and pulmonary air, and this contributes to the maintenance of an adequate partial pressure of oxygen. Haldane and Douglas say that the percentage of red corpuscles and total quantity of the hæmoglobin increase, and maintain that the oxygen is actively secreted by the lung into the blood, but the method by which their determinations have been made has not met with unqualified acceptance. If waste products, which arise from oxygen want, alter the combining power of hæmoglobin, this alteration may not persist in shed blood; for these products may disappear when the blood is exposed to air. Owing to the combining power of hæmoglobin, the respiratory exchange and metabolism of an animal within wide limits is independent of the partial pressure of oxygen. On the other hand, the process of combustion is dependent, not on the pressure, but on the percentage of oxygen. Thus the aeroplanist may become seized with altitude sickness from oxygen want, while his gas engine continues to carry him to loftier heights.

The percentage of CO_2 in the worst ventilated room does not rise above 0·5 per cent., or at the outside 1 per cent. It is impossible that any excess of CO_2 should enter into our bodies when we breathe such air, for whatever the percentage of CO_2 in the atmosphere may be, that in the pulmonary air is kept constant at about ·5 to ·6 per cent. of an atmosphere—by the action of the respiratory centre. It is the concentration of CO_2 which rules the respiratory centre, and to such purpose as to keep the concentration both in the lungs and in the blood uniform; the only result from breathing air containing 0·5 to 1 per cent. of CO_2 is an inappreciable increase in the ventilation of the lungs. The very same thing happens when we take gentle exercise and produce more CO_2 in our bodies.

At each breath we rebreathe into our lungs the air in the nose and large air-tubes (the dead-space air), and about one-third of the air which is breathed in by a man at rest in dead-space air. Thus, no man breathes in pure outside air into his lungs. When a child goes to sleep with its head partly buried under the bed-clothes, and in a cradle confined by curtains, he rebreathes the expired air to a still greater extent, and so with all animals that snuggle together for warmth's sake. Not only the new-born babe sleeping against its mother's breast, but pigs in a sty, young rabbits, rats, and mice clustered together in their nests, young chicks under the brooding hen, all alike breathe a far higher percentage than that allowed by the Factory Acts.

To rebreathe one's own breath is a natural and inevitable performance, and to breathe some of the air exhaled by another is the common lot of men who, like animals, have to crowd together and husband their heat in fighting the inclemency of the weather.

The sanitarian says it is necessary to keep the CO_2 below 0·01 per cent., so that the organic poisons may not collect to a harmful extent. The evil smell of crowded rooms is accepted as unequivocal evidence of the existence of such. He pays much attention to this and little or none to the heat and moisture of the air. The smell arises from the secretions of the skin, soiled clothes, etc. The smell is only sensed by and excites disgust in one who comes to it from the outside air. He who is inside and helps to make the "fugg" is both wholly unaware of and unaffected by it. Flügge points out, with justice, that while we naturally

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avoid any smell that excites disgust and puts us off our appetite, yet the offensive quality of the smell does not prove its poisonous nature. For the smell of the trade or food of one man may be horrible and loathsome to another not used to such.

Ventilation cannot get rid of the source of a smell, while it may easily distribute the evil smell through a house. As Pettenkofer says, if there is a dung-heap in a room, it must be removed. It is no good trying to blow away the smell.

To study the relative effect of the temperature and chemical purity of the atmosphere, I constructed a small experimental chamber of wood fitted with large glass observation windows and rendered air-tight.

On one side of the chamber were fixed two small electric heaters, and a tin containing water was placed on these in order to saturate the air with water vapour. On another side of the chamber was placed a large radiator through which cold water could be circulated when required, so as to cool the chamber. In the roof were fixed three electric fans, one big and two small, by means of which the air of the chamber could be stirred. The chamber held approximately 3 cubic metres of air. In one class of experiments we shut within the chamber seven or eight students for about half an hour, and observed the effect of the confined atmosphere upon them. We kept them until the CO_2 reached 3 to 4 per cent., and the oxygen had fallen to 17 to 16 per cent. The wet-bulb temperature rose meanwhile to about 80° to 85° F., and the dry bulb a degree or two higher. The students went in chatting and laughing, but by-and-by, as the temperature rose, they ceased to talk and their faces became flushed and moist. To relieve the monotony of the experiment we have watched them trying to light a cigarette, and, puzzled by their matches going out, borrowing others, only in vain. They had not sensed the diminution of oxygen, which fell below 17 per cent. Their breathing was deepened by the high percentage of CO_2, but no headache occurred in any of them from the short exposure. Their discomfort was relieved to an astonishing extent by putting on the electric fans placed in the roof. Whilst the air was kept stirred the students were not affected by the oppressive atmosphere. They begged for the fans to be put on when they were cut off. The same old stale air containing 3 to 4 per cent. CO_2 and 16 to 17 per cent. O_2 was whirled, but the movement of the air gave relief, because the air was 80° to 85° F. (wet bulb), while the air enmeshed in their clothes in contact with their skin was 98° to 99° F. wet bulb. If we outside breathed through a tube the air in the chamber we felt none of the discomfort which was being experienced by those shut up inside. Similarly, if one of those in the chamber breathed through a tube the pure air outside he was not relieved.

I have made observations on men dressed in the Fleuss rescue apparatus for use in mines, and exposed in a chamber to 120° F. dry bulb and 95° F. wet bulb. The skin temperature rises to the rectal temperature, and the pulse is greatly accelerated—*e.g.*, to 150—and there arises danger of heat stroke. The conditions are greatly relieved by interposing on the inspiratory tube of the apparatus a cooler filled with carbonic-acid snow. The cool inspired air lowers the frequency of the heart, and makes it possible for the men to do some work at 95° F. wet bulb, and to endure this temperature for two hours.

I conclude, then, that all the efforts of the heating and ventilating engineer should be directed towards cooling the air in crowded places and cooling the bodies of the people by setting the air in motion by means of fans. In a crowded room the air confined between the bodies and clothes of the people is almost warmed up to body temperature and saturated with moisture, so that cooling of the body by radiation, convection and evaporation becomes reduced to a minimum. The strain on the heat-regulating mechanism tells on the heart. The pulse is accelerated, the blood is sent in increased volume to the skin, and circulates there in far greater volume, while less goes through the viscera and brain. As the surface temperature rises, the cutaneous vessels dilate, the veins become filled, the arteries may become small in volume, and the blood-pressure low, the heart is fatigued by the extra work thrown upon it. The influence of the heat stagnation is shown by the great acceleration of the pulse when work is done and the slower rate at which the pulse returns to its former rate on resting.

The increased percentage of carbonic acid and diminution of oxygen which has been found to exist in badly ventilated churches, schools, theatres, barracks, is such that it can have no effect upon the incidence of respiratory disease and higher death-rate, which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The conditions of temperature, moisture, and windless atmosphere in such places primarily diminishes the heat loss, and secondarily the heat production, *i.e.*, the activity of the occupants, together with total volume of air breathed, oxygen taken in and food eaten. The whole metabolism of the body is thus run at a lower plane, and the nervous system and tone of the body is unstimulated by the monotonous, warm and motionless air. If hard work has to be done it is done under conditions of strain. The number of pathogenic organisms is increased in such places, and these two conditions run together—diminished immunity and increased mass influence of infecting bacteria.

THE CORK INDUSTRY IN ALGERIA.

The natural forests of cork trees in Algeria are amongst the chief sources of wealth in that colony. This tree, which is a species of oak, is indigenous to nearly the whole of the northern coast of Africa. In Algeria the principal centres of production are situated in the Department of Constantine, where the forests of cork trees in the district of

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Philippeville cover an area of upwards of 200,000 hectares (nearly half a million of English acres).

Cork is also grown in the western part of the Department of Algiers; it is more rare in the Department of Oran, where it is to be found near Tlemcen and a few other localities.

The production of cork in this colony has increased very considerably during the last quarter of a century. In 1890 the total quantity of cork exported to France and other countries, which amounted to 94,387 quintals (185,801 cwts.) only, amounted in 1910 to 310,376 quintals (610,976 cwts.).

The Algerian cork, which is of excellent quality, is exported principally to Russia, Germany, Austria, Belgium, Holland, Spain, and the United States.

The cork industry is well organised in Algeria, and cork cutting, packing and sorting and all other branches of the trade are carried on, on a large scale, by many firms established at Algiers, Bougie, Philippeville, and Djidjelli, who either purchase the raw cork direct from the forests controlled by the Government or from private owners.

A large trade in corks for bottles is carried on in most of the principal towns, such as Algiers, Oran, Bougie, Djidjelli, Collo, Philippeville, Bona, Calle and Constantine.

The virgin cork, which at one time was considered valueless, now finds a good market in England and Germany.

The cork is principally shipped from the ports of Algiers, Bougie, Oran, Philippeville and Bona.

The export of cork from these ports shows an increasing tendency since 1902, as will be seen by the following statement:—

	To France.	To Other Countries.	Total Exports.	
	Quintals.	Quintals.	Quintals.	English tons.
1902	30,191	40,589	70,780	6,956
1905	79,866	161,645	241,511	23,771
1908	93,506	182,592	276,098	27,175
1910	80,986	229,390	310,376	30,549

THE COCONUT INDUSTRY OF PANAMA.

Panama has for generations been famous for coconuts, and one of the best known poets of the tropics has called that region "the land of the coconut tree." These nuts form one of the staple exports of Panama, over £30,000 worth having been sent in 1910 to the United States. The coconut-palm is said to have as many uses as there are days in the year; and it supplies man with food, drink, medicine, clothing, light, and household utensils. Whether the tree came originally from the Eastern Archipelag native of America—and this latter h according to the International Union of Republics, seems the more tenable—it ha all over the tropics, and grows wild or is c in every country of the Pan-American Usually seen along the coast, it nevertheless well at an elevation of 4,500 feet above the of the sea. The life of the bearing tree ma the century mark, but the best productive of the coconut-palm is from eight to fort It begins to yield, if in favourable condi the fifth year, and yields a profitable harv cultivator. The coconut is really, at t time, a commercial article, and is fin more and more into the markets Twenty-eight per cent. of all the coc in the world are grown in the Ame however, they are scattered over a m area for each palm than is the case thereby making the work of collecting more difficult and expensive. Th natural palm regions have never worked, but the approaching comp Panama Canal will rapidly bring within the radius of profit. Both coas have already benefited by the increase for transport of the last few years, and tions are receiving fresh attention, whil areas, on both mainland and islands their long-standing popularity.

PRODUCTION OF CAPERS SOUTH OF FRANC

Capers, the flower-buds of the ca still a product of some importance of France, notwithstanding that th grown in Corsica, Algeria, Tunis, Spai in the Crimea. The capers of Prov seems to be the natural home of the pl considered to be superior in quality to those elsewhere, but the falling-off of the produc here must be attributed to foreign competiti The growing of capers in France is almost exclsively restricted to the Departments of the Var an Bouches-du-Rhône between Marseilles and Toulon.

It is, however, only on the hills of Roquevaire, about twelve miles north-east, and Cuges, sixteen miles east of Marseilles, that a regular cultivation of this plant may be said to exist. At Cuges, where formerly 30 hectares (about 75 acres) were cultivated, and produced annually upwards of 180,000 kilogs. (396,900 lbs. = 177 tons), the production at the present time of capers does not exceed 70,000 to 80,000 kilogs. (70 to 80 tons). The total production of Provence is now estimated at 150,000 kilogs. (330,750 lbs. = 147¾ tons) yearly.

The gathering of the capers usually commences towards the end of May, as soon as the buds are the size of a small pea, and the picking continues all the month of June. The bushes are picked

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once a week at first, and oftener as the season ses, so as not to allow the buds to become too This is done chiefly by women, who, on an ge, can collect 12 kilogs. to 15 kilogs. (26½ lbs. lbs.), whilst an exceptionally good worker etimes picks even 20 kilogs. (44 lbs). The king is paid for at the rate of 25 cents. to cents. per kilog. (1¼d. to 1½d. per lb.) for this rk.

e bushes yield from ½ kilog. to 2½ kilogs. (1 lb. lbs.) of capers every season.

r being stripped of any loose leaves, and the cotton round them removed, the buds ed by being passed through sieves with zed meshes. They are then spread (not on cloths to dry in shady and well- rooms. When dry, and ready for pre- hey are placed in jars or other vessels g strong wine vinegar, which sometimes d with tarragon or other herbs.

re classified according to size, the best, *i-pareilles*, those passed through a meshes of 6 millimetres (·2362 inch); w the *surfines*, through 8-millimetre 19 inch); the *capucines*, a 9-millimetre 43 inch); and the *capotes*, a 10-milli- esh (·3937 inch). The coarser varieties vn as *fines* and *demi-fines*. The capers s district are chiefly exported to London, , and Hamburg.

T OF EGGS FROM RUSSIA.

rade in Russia appears to be in a very condition at the present time, judging atistics published by the Custom House of that country. The following figures ncrease of 22·84 per cent. in number, and e value of the eggs exported in 1911, as with those in 1910:—

	Number.	Roubles.*	£ Sterling.
1911 . . .	3,683,000,000	80,747,000	8,523,294
1910 . . .	2,998,000,000	63,700,000	6,723,888
Increase . .	685,000,000	17,047,000	1,799,406

The number of eggs exported last year from Russia to the principal commercial nations of Europe, was as follows:—

United Kingdom . .	1,308,000,000
Germany	1,118,000,000
Austria-Hungary . .	793,000,000
Denmark	78,000,000
Other Countries . .	386,000,000
	3,683,000,000

* The rouble = 100 kopecks = 2s. 1⅓d. The kopeck = about one farthing.

The prices, on the spot, last year, have ranged higher than has been the case during the four previous years, and averaged 21 roubles 92 kopecks (£2 6s. 3d.) per 1,000 in 1911, as compared with 21 roubles 24 kopecks (£2 4s. 10d.) in 1910; 21·87 roubles (£2 6s. 2d.) in 1909; 21·19 roubles (£2 4s. 9d.) in 1908; and 21·43 roubles (£2 5s. 3d.) in 1907. The highest prices reached were at Kazan, when they averaged 24 to 25 roubles (£2 10s. 8d. to £2 12s. 9½d.) per 1,000.

OBITUARY.

JOHN LEIGHTON, F.S.A.—By the death of Mr. John Leighton, which took place at Harrow on the 15th inst., on his ninetieth birthday, the Society loses one of its oldest members, as he became a life member in 1851. Mr. Leighton's work takes us back to the Exhibition of 1851, as some of the exhibits of bookbinding shown there were from his designs. In some of the obituary notices which appeared in the daily papers, it was stated that he was a member of the Royal Commissions for the Exhibitions of 1851 and 1862; but this is not correct.

He was a prolific and excellent designer and book illustrator, and produced also a number of books, some of which were issued under the pseudonym of "Luke Limmer." The volumes of the *Journal*, from the seventh down to the fifty-first, are full of communications from him on the most varied subjects. In 1859 he read an admirable paper on Bookbinding, which contains much valuable information, and may still be referred to with advantage. A second paper read by him in 1888 on a method of conducting elections through the post contained a proposal which was sensible enough, but of no special originality. He was a very frequent attendant at the Society's meetings, and constantly took part in the discussions during a period of nearly fifty years. Most of his remarks dealt with artistic matters, and were of value. But he was a man of singularly versatile interests, and he was always ready to speak on matters of which he had no special knowledge, though his remarks were often shrewd and interesting. The last occasion on which he took part in the discussion was in 1902, when he made a few remarks on a paper read by Dr. Gustave Goegg on the Simplon tunnel and railway. His great age and failing health prevented his taking part in the Society's meetings, or producing any artistic work, of late years. But his work extended throughout the whole of the last half of the nineteenth century, and during that long period he contributed his share to the progress of design, and he was certainly one of the pioneers in the advance of industrial art.

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GENERAL NOTES.

The Cultivation of the Castor Bean in Jamaica.—The remunerative prices which castor oil is bringing in foreign markets have awakened renewed interest in the castor plant. The industry apparently is one that does not require much skill in planting, and, once established, the seeds propagate themselves, fertilising the soil not being necessary. The plant has been cultivated by the Jamaican peasantry for years, and a considerable acreage is now under cultivation. In the East Indies, where the castor bean is extensively cultivated, it yields as much as five tons of seeds to the acre. In Jamaica there are several species, and recent experiments show that the nut grown there gives a larger yield of oil than the East Indian product. Experience seems to indicate that the castor plant is practically immune from insect pests. The oil has become very popular of late as a lubricant. No doubt machinery for crushing the seeds will shortly be required.

The Tanning Industry in Spain.—The tanning of leather is of considerable importance in Spain. There are no official statistics published regarding this industry, but a reliable estimate by persons well informed on the subject places the total number of tanneries in the country at about fifteen hundred, employing approximately 22,500 work-people. Although these tanneries are distributed over the entire country, the Catalonia district is the principal centre of the industry, there being in the city of Barcelona alone about one hundred factories, turning out a great variety of products as sole leather, tanned cowhides and calfskins, morocco leather, dressed sheep and other skins, etc. The greater part of the leather produced finds its way to the numerous shoe factories in Catalonia and the Balearic Islands. Besides supplying practically the entire home demand, the Spanish tanneries also export their manufactures to foreign countries, Barcelona being the chief port of export, followed by Valencia and Palma. Heretofore the leather was all tanned by the old method—that is, leaving the raw hides in the extract for a few weeks; but the factories are now beginning to adopt the modern methods, by which the hides can be tanned in a much shorter period.

Oil for Use in making Umbrellas in Japan.—The vegetable oil used in making paper umbrellas in Japan is pressed out of the seeds of *Perilla ocimoides*, an annual plant which resembles *Perilla perkinensis*. This oil is made in the Tochigi, Saitama, Chiba, Miyagi and Ibaraki prefectures. These prefectures are famous for the production of the seeds and oil. Sandy ground is favoured for the cultivation of the plant, and the oil is extracted from the seeds by presses. The yield of seeds is estimated at twenty bushels per acre. The annual production throughout Japan amounts to 300,000 to 350,000 bushels, from which over a gallon of oil per bushel is extracted, according to Japanese statistical returns. The oil before being used is boiled and then cooled until it can be applied by hand to umbrellas with a piece of cloth or
No machinery or tools are used in applyin
oil. When the oiling is completed the umbr
are exposed in the sun for about five hours.
oil is also used in making paper lanterns, oil p
and artificial leather, and in preparing materials
making printing ink, paints, varnish, and lacquer.

Syrian Apricot Paste.—The apricot pas
industry has long been in vogue in Damascus a
all along the valley of the Barada River. T
methods employed are very simple. A hole,
or three feet deep, and of a circumference
portionate to the crop to be treated, is dug b
farmer, and usually lined with cement. T
apricots are stoned and thrown into this
beaten into a pulp. The primitive m
kneading the fruit with bare feet is st
resorted to. The pulp is then spread ou
boards and placed under trees and in sha
to dry. These boards are of uniform siz
paste is so spread out as not to be thi
one-tenth of an inch when dry. Th
prepared, when dry, weigh about 5
look like sole leather. The price varies
quality, which is determined by the c
thickness, from elevenpence to one shi
twopence per 5½ lbs. The annual produ
this paste, which is known in Syria as
reddin," reaches about four thousand ton
increasing yearly. There is a large ma
kamereddin throughout Syria, and of l
considerable shipments have been made t
Roumania and Germany. It is state
Germany kamereddin is imported for
facture of jam, which has the full aprico

Ostrich Farm at Nice.—The last con
for the district of Nice states that an os
started there some years ago by an E
Mr. W. S. Belfield, has yielded interesti
Twenty-three birds were imported from
California, and the climate of the South
is eminently suitable for the breeding, for o
birds have been hatched by artificial incuba
From this farm there has been an export to t
following places, viz., Basle, Milan, Palermo,
Havana, St. Antonio, Paris, and London. A big
turnover is done by the selling of ostrich feather goods, which are made up by the hands of the factory connected with the farm and sent to all parts of the world. The factory now employs over 300 hands, all the girls being paid by piece work and earning good wages. The commerce of the port of Nice is in a fair way to experience great development, as a new line of railway, opened recently, has placed Grenoble within easier reach of Nice than of Marseilles, while an Italian line under construction will prove equally beneficial in connecting Cuneo and Turin with Nice. An improvement in the Paris, Lyons, and Marseilles service, too, has, for the first time, brought the chief towns of the French Riviera in direct fast communication with Paris, as regards second and third-class passengers. This will prove a convenience to English travellers, as until the change the fast evening train from Paris did not go beyond Marseilles.

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Journal of the Royal Society of Arts.

No. 3,123. VOL. LX.

FRIDAY, SEPTEMBER 27, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

EXAMINATIONS.

The programme of the Society's examinations for the coming year is now ready, and copies have been sent to the examination centres throughout the United Kingdom. (These now number nearly 500.)

The programme contains the regulations, time-table, syllabuses for all subjects, the papers set in 1912, together with the examiners' reports on the work done, and a summary of the results for 1912.

Copies may be obtained on application to the Secretary, price 3*d.*, post free 4½*d.*

It is hoped, in the course of the next year or two, that the examinations will everywhere be conducted and supervised by the local education authorities only. As stated in the *Journal* of February 16th last, a start in this direction was made in London this year, and the London County Council Education Committee now undertakes the entire supervision of the examinations in the County of London, where nearly 10,000 candidates sat for examination in 1912.

Efforts are now being made to bring about a similar state of things in the large cities and towns where the examinations are held. In most of the smaller places this is already the case. The Council are of opinion that by placing the supervision of the examinations in the hands of independent local authorities the value of the Society's certificates will be greatly enhanced.

In 1912, in the commercial examinations, 28,057 candidates worked 34,002 papers. In addition to these, 296 candidates were examined in practice of music, 633 took the viva voce examination in modern languages, and there were 45 candidates for the special Army shorthand examination. Altogether, therefore, 29,031 candidates were examined by the Society this year.

THE ROYAL SOCIETY OF ARTS.*

By Sir Henry Trueman Wood, M.A.,
Secretary of the Society.

X.—The Presidency of the Prince Consort.
(1843–1861.)

In the last article which dealt with the internal organisation and constitution of the Society,† we left off at the point when a Council had just been appointed, and a Charter obtained for the Society. The task before the new Council was no light one, and it started on its work of reform with many difficulties in the way. It had to rescue the Society from the condition of torpor and ineptitude into which it had fallen, to arrange its finances, and indeed to provide funds for its work. It had to justify its existence, to rouse public interest, and to find fresh directions for its efforts to carry out the objects for which the Society was originally founded. To do this, it had first to organise itself, and to distribute the work between itself and the various committees into whose hands the details might safely be entrusted. At first the original six "Premium" Committees were maintained, the committee on "Miscellaneous Matters" being merged in the Council. But it is hardly worth while to enter into an account of the various changes which were made in the number and duties of the committees. Sometimes the number was increased; sometimes it was diminished; at one time there were as many as thirty. But eventually the sensible system was adopted of appointing committees from time to time as questions arose for their consideration.

Inasmuch as all the business of the Society at once passed under the control of the new governing body, there was nothing left to occupy the attention of the ordinary meetings, which had

* The previous articles of the series appeared in the *Journals* of June 9th and 16th, September 22nd and 29th, November 3rd, 1911, January 12th, 19th and 26th, April 5th, June 14th and 21st, and July 12th, 1912.

† *Journal*, April 5th, 1912, p. 527.

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hitherto been taken up in the award of the premiums, and in the continual discussion of the Society's rules and orders. This naturally led to an increased importance in the scope and character of the papers, the reading of which rapidly became, at first, the most important, and very soon the only function of these meetings. By the time we have now reached, the system started by Aikin had grown and developed, until it became the recognised practice for every Wednesday evening during the session to be occupied, either by a paper, followed by a discussion, on some new invention or some novel industrial development, or else by a lecture (which was not discussed) on some branch of industry, some fresh application of science, or, less frequently, some application of artistic principles or methods.

Perhaps unfortunately, the series of lectures, for the introduction of which, as previously mentioned, Aikin was responsible, gradually died out. Aikin himself had no successor among the officials able and willing to devote himself to popular exposition, though Scott Russell had all the capacity for such work had he cared to undertake it. And so after Aikin's time the Society, less fortunate than the Royal Institution, found no Faraday to draw intelligent audiences to its meeting-room by brilliant expositions on the applications of science and art, and it really was not until the receipt of the Cantor bequest enabled the Society to provide courses of lectures that this valuable means of diffusing knowledge on industrial subjects was utilised. There was, however, no very great difficulty in securing suitable topics or capable authors for filling up the programme for the Wednesday evening meetings, and this important portion of the Society's labours rapidly developed, and eventually became its principal duty.

But if the regular routine of the Society's work was thus provided for, there were many outside objects to which the Council now began to direct its attention. In this they were very greatly helped by the fact that they had as the Society's President the Prince Consort, who assisted them not only by his influence, which at the time was naturally much less powerful than it became in later years, but by the interest which he took in, and the attention which he devoted to, the Society's affairs during the first years of his Presidency. He realised—and he himself told the Society—that the main object of its existence was the application of science and of art to industrial purposes. These were matters in which he took a genuine personal interest, and so long as the Society was ready to promote the objects he had at heart, he was quite willing to assist it as far as the numerous other occupations of his exalted position allowed him sufficient leisure. It has often been said that too much credit has been given to the Prince Consort for the Society's success about this time, especially for its success in starting the 1851 Exhibition, but a careful study of the Society's records has satisfied the present writer that this influence was by no means exaggerated. It is quite clear that the Prince did not initiate the reforms—economic, social, and industrial—which started from the Society of Arts. But most new suggestions of any importance appear to have been submitted to him, and he discriminated with extreme shrewdness between those which were of value and those which it was not worth while to press. He evidently had an extremely quick and active mind. His judgment on the questions submitted to him seems generally to have been prompt and correct, and this is surely as much as can reasonably be looked for from one occupying a position such as he occupied. The period on which we are now engaged may justly be considered as the period of his Presidency, and we may have a little more to say about the value of the services he rendered the Society when we come to deal with the termination of that Presidency by the Prince's death in 1861.

During that period by far the most important of the public works carried out by the Society was the starting of the two great Exhibitions of 1851 and 1862. The history of these two Exhibitions, so far as the Society was associated with them, has been sufficiently dealt with in two articles by the writer, which appeared in the *Journal* some years ago.* The next most important piece of public work was the establishment and organisation of a system of examinations carried out simultaneously all over the kingdom, which had the very greatest influence on industrial, middle-class, and scientific education during the fifties and sixties. For an account of this work reference may be made to a previous article in the *Journal*,† and consequently nothing need now be said, either of the two Exhibitions or the examinations. This article will, therefore, be devoted to the consideration of the various other matters which

* "The Early History of the 1851 Exhibition," *Journal*, Vol. XLIV. p. 889 (November 6th, 1896); "The Society of Arts and the 1862 Exhibition," *Journal*, Vol. XLV. p. 80 (December 18th, 1896).

† See footnote, p. 1013.

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the Society had in hand during the period which extended from the date of its charter (1847), or the assumption of the Presidency by Prince Albert (1843), down to the date of the Prince's death (1861) and the holding of the second great Exhibition in 1862.

The subjects pursued by the Society during this period were so diverse and so numerous, that it is not at all easy to give any connected history of its proceedings. Perhaps, when those who had in hand the reconstitution of the Society realised that the purpose of its original institution had been served, and that some other methods must be devised for carrying out the objects of its foundation, they found it difficult to set a limit to the scope of its work, and the result was that they extended its operations a good deal beyond what was intended or contemplated by its original founders, somewhat, indeed, beyond what was intended by the framers of its charter.

The newly-constituted Council was a strong body, and the very fact that it was newly-constituted made it anxious to effect reforms, not only in the Society itself, but in all the departments of public life and administration with which the Society could, by any reasonable extension of its objects, claim association.

The Council, as a body, was quick to realise the value of the Society's organisation as an instrument for the promotion of many useful social and economic as well as industrial changes. Many of its members were active-minded, energetic men, keenly interested in the promotion of special reforms, full of enthusiasm for the causes they had espoused, and anxious to utilise the growing influence of the Society for the realisation of their own particular objects.

Prominent among these was Henry Cole, a man of exhaustless energy, full of enthusiasm for his own ideals and of confidence in their value. At the instance of Scott Russell he joined the Society in 1846 and at once became a member of the Committee of Fine Arts. In January of the following year we find him attending a meeting of the Council, to explain, as a representative of the committee, the scheme he had laid before them for annual exhibitions of the work of British artists, and suggesting as a commencement an exhibition of the works of Landseer, then at the height of his popularity. In the same year (1847) he was nominated for the Council, and from that time till the date of his death, in 1882, he continued to exercise the strongest personal influence over the Society, influence which, for the first half or so of this period, really amounted to absolute control. A man of singularly active mind, he was perpetually conceiving fresh projects for the improvement of public welfare and the benefit of mankind. Some of these were eminently successful, such as the Victoria and Albert Museum, and, it may be said, the 1851 Exhibition, since, if he did not originate the idea of a great international exhibition, it was his capacity for organisation that rendered the scheme practicable. Others naturally enough were failures, but the bulk of his proposals were valuable, and of genuine public utility. With very nearly all the Society of Arts was associated. He utilised its influence and its organisation to the full, and he repaid its help by useful guidance and administrative direction.

He was not a skilful financier. Certain of his schemes cost the Society dear, but if he wasted some of its funds, it was mainly due to him that the Society had any funds to waste. It is the matured opinion of the writer, who knew him well and admired his great qualities, without being in the least unaware of his faults, that Henry Cole ought to be looked on as the second founder of the Society, and that it was owing to his influence and authority that the Society was raised from a state of impotence and insignificance to a condition of prosperity and influence. This does not imply that he started the improvement. He did not. The Society had been rescued from dissolution before he became a member of it; but he infused fresh vigour into its growth, and in a few years from his joining its governing body it had trebled the number of its members and quadrupled the amount of its funds.

It may be admitted that Cole had in full measure the defects of his qualities. He liked having his own way, and he generally got it. He disliked opposition, and was ruthless with his opponents. He was a born fighter, and his methods of fighting were often questioned and disliked. Naturally enough, this made him unpopular, while the objects he sought often laid him open to the ridicule which is generally the lot of those who first advocate schemes for the accomplishment of which others in a later age are hailed as the benefactors of their kind. However, he cared little for ridicule or for unpopularity, so long as he got what he wanted, as he usually did. His best friends and admirers must wish that he had had greater regard for the feelings of others, and that he had been content to attain his objects without thrusting aside and trampling over those who did not agree with him. But that was not his way, and

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perhaps, gentler methods might have proved less successful. At all events, it is likely that they would have been slower, and of all things, delay was hateful to the impatient soul of Henry Cole.

Of course, he had a fight soon after he joined the Council, and, unhappily, it was with one of the best and staunchest friends of the Society, Thomas Webster. Webster, doubtless disapproving of Cole's arbitrary methods, and his somewhat reckless expenditure, opposed his proposals for annual exhibitions, industrial and pictorial. His criticisms were supported in the Council, and, in 1850, Cole resigned. But he organised an opposition at the next annual meeting, and circularised the members, with the result that at a largely attended meeting on April 3rd, 1850, when 207 members voted, Cole and his friends were elected by a considerable majority, while Webster and his supporters were turned out. Inasmuch as it was Webster who, by the introduction of much-needed reforms, had saved the Society from certain dissolution in 1842,* the vote of the electors appears ungracious, especially as bitter feeling was engendered by it. But, as above said, those who got in Henry Cole's way generally had to get out of it. His differences with Webster are the more to be regretted as Webster had the scientific knowledge to which Cole never made any pretensions, and his experience as a great patent lawyer might not improbably have led the Society to take a larger part in the guidance of industrial progress and the application of science to manufactures than it really did take.

Cole was Chairman of the Council in 1850, and again in 1852. One of the most prominent of his successors was Wentworth Dilke, who was Chairman in 1857 and 1858. He took an active share in the arrangements for the two great Exhibitions of 1851 and 1862, and a baronetcy was conferred upon him on the close of the Exhibition of 1862. He was so keen about the Society's welfare that he brought his relations into it. His father, the well-known editor of the *Athenæum*, became a member of the Society in 1849—Dilke himself having joined four years earlier—and he made his two sons, Charles and Ashton, life members when they were boys. Another very energetic and capable Chairman was Sir Thomas Phillips, who succeeded Dilke, and was found so useful in the post that the by-laws were altered so as to allow him to hold the Chairmanship for four consecutive years, 1859 to 1862. Sir Thomas Phillips was a man of some character. He earned his knighthood by his action in quelling a Chartist riot in a mining district of South Wales, when he was wounded. He was a liberal and public-spirited man. Besides devoting himself strenuously to the Society's work, he took an active part in the work of King's College and many metropolitan societies.

* *Journal*, April 5th, 1912, p. 537.

Another most useful member was Harry Chester, who was Chairman in 1853. He was the originator of the Union of Mechanics' Institutions and of the Society's examinations, and continued an active worker on behalf of the Society until his death in 1868. He held certain official appointments, including the Assistant Secretaryship of the Committee of Privy Council on Education. The public work he did, mainly through the Society of Arts, never received due recognition; he is even ignored by the "Dictionary of National Biography." Lieut.-Colonel Owen was elected Chairman in 1853, but was compelled by pressure of his official work to decline office before actually taking any active part in it. But he was in many respects a useful member of the Council, and took his full share of its work. He was a brother of Sir Philip Cunliffe-Owen, who in later years was closely associated with the Society. The Rev. James Booth became Chairman in 1855. The work he did in suggesting the establishment of the Society's *Journal*, and in the development of its examinations, will be referred to later on.

Other Chairmen of Council during this time were Colonel W. H. Sykes, M.P., F.R.S. (1856), Chairman of the Board of Directors of the East India Company; Lord Ebrington (1854), afterwards Earl Fortescue, who lived and preserved his interest in the Society until 1905; and William Saunders, F.R.S. (1851), a naturalist of some note in his day, who wrote much on botany and entomology, and served as President of the Entomological and Horticultural Societies.

Amongst other members of the Council who took a prominent part in the Society's work, and attended most constantly at its meetings, the following should be mentioned: Dr. Lyon Playfair (afterwards Lord Playfair), the eminent chemist; Richard Redgrave, R.A., and his brother Samuel, the author of the useful Dictionary of Artists of the English School; Sir Joseph Paxton, who designed the 1851 Exhibition building; Robert Stephenson, the great engineer; Richard Dawes, the Dean of Hereford, who gave valuable help in organising the examinations; J. C. Macdonald, the manager of the *Times;* Sir W. H. Bodkin, the eminent

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lawyer, who co-operated with Thomas Webster in the reform of the Society; Thomas Graham, Master of the Mint; William De la Rue, F.R.S.; Sir John Pakington (afterwards Lord Hampton); Sir William Page Wood (afterwards Lord Chancellor Hatherley); J. J. Mechi, the enthusiastic agriculturist; Sir William Fairbairn, the engineer, who was a commissioner for the 1851 and 1862 Exhibitions, and took a particularly active part in the organisation of the latter; Thomas Winkworth, a man not much known outside the Society, but one who did much hard work within it for the Exhibitions and other matters; Thomas Twining, the earnest advocate of many philanthropic schemes; Joseph Hume, the Radical M.P. and economical reformer; Sir John Boileau, an archæologist of repute; and William Tooke, for many years a Vice-President, and the Society's honorary solicitor.

These were among the most active supporters of the Society. Something may now be said about the permanent officials. In the early part of the period with which we are now concerned, the office of Secretary changed hands rather frequently. In the ten years, 1843–53, there were six occupants of the post. As previously mentioned,* when Graham retired in 1843 (after holding office for two years only), Wishaw was appointed, and in 1845 he was succeeded by John Scott Russell. Scott Russell was a worthy successor to Templeman and Aikin, and, indeed, as a scientific man he was superior to either. Born in 1808, he was thirty-six years of age when he came to London, and became a member of the Society of Arts. He had already acted as Professor of Natural Philosophy at Edinburgh, and had acquired a reputation for his original researches on Wave Motion. He had also carried out, with much success, the construction of several large vessels in which his principles were embodied. These were all designed by him as manager of the shipbuilding establishment at Greenock, afterwards belonging to Messrs. Caird.

Before his election as Secretary, he had taken an active part in the deliberations of the Committee on Miscellaneous Matters. Though he was too active-minded to confine his attention to the Society's work, he made a most efficient and energetic Secretary, and took his full share in the work of reconstructing the Society, which may be said to have been completed during his term of office. The steady improvement in the character of the papers brought before the evening meetings was certainly to a large extent due to him. He seemed ever ready to place at the disposal of the Society not only his abilities, but what he had in much less abundance, the contents of his purse; for he frequently took upon himself the provision of expenses which assuredly he was not called upon to meet, and which, indeed, he could not properly afford.

His energy in helping on the preparations for the 1851 Exhibition led to his being appointed, jointly with Mr. Stafford Northcote (afterwards Lord Iddesleigh), Secretary to the Royal Commission when it was appointed in January, 1850. After this he resigned the Secretaryship of the Society, and, having been elected a life member, was placed on the Council. In later life he resumed the practice of his profession, with a result that cannot be better stated than in the words of the author* of the account of his life in the *Proceedings of the Institution of Civil Engineers*—

"In summing up Mr. Scott Russell's connection with the profession of naval architecture, it may be said that on commencing his career he found it the most empirical of arts, and he left it one of the most exact of engineering sciences. To this great result many others contributed largely besides himself; but his personal investigations, and the theories he deduced from them, gave the first impetus to scientific naval architecture." †

A man of real genius, he took high rank in his profession, among a race of great engineers, and in his own particular branch of it he was far ahead of his contemporaries. But, spite of his great talents, his worldly success was never equal to his deserts, and when he died in 1882 it was in straitened circumstances.

Scott Russell's successor was George Grove, who was appointed jointly with Russell in February, 1850, and, after a month's trial, sole Secretary in March. Grove, like his two predecessors, was an engineer, and he had practised his profession to some extent before his appointment, though never afterwards. His tenure of office was very short, for when the Crystal Palace was established at Sydenham he was (in May, 1852) offered the appointment of secretary, and thereupon he gave up his post at the Society. He was a thoroughly capable official—in this respect superior to his immediate predecessors, and with a longer period of service he would, doubtless,

* *Journal*, April 5th, 1912, p. 538.

* Sir George Holmes, a pupil of Scott Russell's, and at one time Secretary of the Institution of Naval Architects.

† Obituary notice, *Proceedings of the Institution of Civil Engineers*, Vol. LXXXVII. p. 435.

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have left his mark on the administration of the Society. As it was, his powers were devoted to other institutions—first the Crystal Palace, and afterwards the Royal College of Music—where they had full scope and were greatly appreciated. Grove was the last Secretary to live on the Society's premises. When he quitted office the house in which all the Secretaries since Templeman had lived, and in which two of them (More and Taylor) had died, was added to the Society's offices.

When Grove retired, Edward Solly, long an active member of the Council, was appointed Secretary, and held the office for a year—May, 1852, to May, 1853. Solly was an old and active member of the Society. He had been elected in 1838, and had served on the Council since 1850. At the time of his appointment as Secretary he was actually deputy-chairman. He was a chemist of some reputation. He became a Fellow of the Royal Society in 1843, and in 1845 was appointed Professor of the Addiscombe Military College. He resigned that he might devote himself to the organisation of the Trade Museum started by the Society, of which more hereafter. Though not a man of brilliant talent, he possessed considerable intellectual powers and some literary capacity, which he devoted in later life principally to antiquarian and bibliographical subjects. He died in 1886.

Solly was succeeded in the Secretaryship by Peter Le Neve Foster, whose genial and kindly nature gained him the regard and esteem of all those with whom he worked. He is still remembered by many of the older members of the Society; by none outside those of his own family can his memory be more affectionately cherished than by the writer of these notes. He, like his predecessor, had for some years been connected with the Society, which he joined in 1837, at the instance of his grandfather, Abraham Osorio, who had become a member in 1800. His father (also Peter Le Neve) joined the Society in 1807, so that he had a long family connection with it. When the first Council was formed, he became an *ex officio* member of it, as he was at the time Chairman of the Committee of Accounts. He was at once elected treasurer, and this office he held till 1852, when he became an ordinary member of the Council.

Foster took his degree in the Mathematical Tripos of 1830, and became a Fellow of his college (Trinity Hall). In 1836 he was called to the Bar at the Middle Temple, and he practised as a conveyancer until his election to the secretaryship, which he held for a period of not quite twenty-three years, till his death in 1879. He had taken his full share in the reorganisation of the Society, and by the time that he became Secretary its various difficulties had been surmounted, and its second era of prosperity had commenced. This prosperity continued unabated during his term of office, and much of the credit for this state of things may fairly be claimed for him.

If he did not originate any changes or introduce many fresh ideas, he carried out efficiently and well all the executive work of the Society, and it may fairly be said that its public reputation for sound practical work stood a good deal higher at his death than it did when he became secretary. Possessed of much sound scientific knowledge, of wide general reading, and endowed with considerable intellectual capacity, he was well qualified for the duties of his office, for which also he was well fitted by character and taste. Of a kindly genial nature, singularly patient and forbearing, tactful and full of common sense, he made an admirable Secretary. If he was devoid of ambition and inclined to be somewhat "easy-going," this only made him more contented with his duties, and never induced him to neglect them, for he was a steady and regular worker, who took a pleasure in his work.

He had various interests outside the Society. Among the first to practise, as a scientific amateur, the art of photography, he was one of the founders of the Photographic Society, and for many years on its Council. He followed with interest the developments of the art during its most interesting period, from the first photographic application of collodion, to the introduction of the gelatine dry plate, and wrote a good deal on the subject. At one time he served on the Council of the British Association, and was for thirteen years secretary of Section "G," Mechanical Science.*

Some reference is also due to certain of the other officials of the Society. Of these Samuel Thomas Davenport comes first, both from his seniority and because he devoted his whole life to the Society's service.

His appointment in 1844 as a sort of clerk or assistant to Wishaw has been mentioned,† and from that date he served the Society faithfully and well in various capacities, being always

* The fullest account of P. Le Neve Foster will be found in the notice published after his death in the *Journal*, Vol. XXVII. p. 316. There is also a short life in the "Dictionary of National Biography."

† *Journal*, April 5th, 1912, p. 158.

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ready to undertake any work that might be required of him. His pay was very moderate, and occasionally small grants were made to him, which were certainly well deserved. In April, 1848, he was given the title of assistant secretary, and in January of 1849 his salary was made up to £100 a year. Six months later W. Ellis was appointed assistant secretary, but he only held office for less than a year, as he resigned in March, 1850, when the office was left vacant. Davenport was then made "Curator and Collector," at a salary of £150, and in 1853 his title was changed to that of "Finance Officer," afterwards modified to "Financial Officer," an appellation which he bore, with much personal pride and gratification, till his death in 1876. It would not be easy to overrate the value of Davenport's services to the Society, though they were in the earlier part of his life of an unpretending nature. Later on, his very considerable experience, and his minute knowledge of the Society's history, gave him much influence with the Council, and his opinion in matters connected with the internal administration of the Society carried great weight. He had had in youth some artistic training, and would have made a capable engraver had he followed the profession for which he was intended, but in other subjects he was mainly self-educated. He had acquired a curious and extensive knowledge of the contents of the Society's records, and this led him to produce, in the form of a paper read at one of the meetings in 1868, a short history of the Society,* which has before been referred to in this series of articles. Though it contains much information, it is badly put together, and shows a want of literary skill. The same criticism may be applied to his other communication to the Society, on "Prints and their Production,"† though it has a distinct value as recording much which is not to be found elsewhere about the earlier attempts to produce printing surfaces by means of photography, since at the date of the paper many such attempts had been made, but none had yet succeeded.

His single-minded and whole-hearted devotion to the interests of the Society rendered him a zealous and valuable official. The present writer who, of course, knew him intimately during the last eleven years of his life, and had for him a genuine liking and regard, can testify to the kindliness of his nature and to his popularity amongst those with whom he was associated.*

From the date of Ellis's resignation in 1850 to the middle of 1852, the office of assistant secretary was left vacant. In June of that year James Forrest, who had previously been assistant secretary to the Institution of Civil Engineers, was appointed. He held office till April, 1856, when he resigned, in order that he might return to his old office at the Civil Engineers, with a view to his succeeding Charles Manby, who was about to give up the secretaryship of the Institution. This arrangement was duly carried out, and Mr. Forrest was appointed in 1860. All engineers know with what credit to himself, and with what benefit to the Institution, he filled his office, till he resigned in 1896. His name will always be associated with the Institution by the Forrest Lectures, founded to commemorate his secretaryship. Mr. Forrest is still living in retirement at St. Leonards, now one of three surviving representatives of the Society of Arts of sixty years ago.

It was determined to fill up the vacancy caused by Forrest's retirement by an open competitive examination, the time being one when the value of test examinations ranked higher than it does now after half-a-century's experience. Accordingly, the appointment was advertised, and the candidates who applied were submitted to a regular examination, both viva voce and by papers. Charles Critchett, who had taken his degree at Cambridge (Trinity) in 1855, was successful, and he was duly appointed. It must be said that the experiment was quite successful. Critchett made a perfectly efficient assistant secretary for thirteen years. He resigned of his own accord in 1869, though his connection with the Society was preserved by his appointment as educational officer, in which capacity he had a nominal responsibility for the conduct of the examinations. He held this office till 1879, and when he gave it up he was made a life member. As he was quite comfortably provided for there was no need for him to work, and he naturally enough preferred a life of leisure to a continuance of official routine. He was a man of artistic tastes, cultivated manners, fond of society, and popular in a large circle of friends. He died in 1906.†

Having dealt with the principal individuals who carried on the Society's work during the

* *Journal*, Vol. XVII. pp. 10, 127, 143, 160. He had previously (in 1864) read a paper on the Society's promotion of industrial education, *Journal*, Vol. XIII. p. 88.

† *Journal*, Vol. XVIII. p. 62. The paper had been preceded by an article on the same subject in the *Journal*, Vol. XIII. p. 131.

* A notice of Davenport will be found in the *Journal*, Vol. XXIV. p. 139.

† A notice of his life will be found in the *Journal*, Vol. LIV. p. 528.

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period which began with its incorporation and ended with the 1862 Exhibition, we may pass on to a consideration of the work itself. At the commencement of the period, the attention of the Council was chiefly occupied with the organisation of the first great exhibition, and during its last years with the preparations for the second; but in spite of this, time was found for a great variety of other business, the chief items of which have now to be described.

Of these, the most important was education, industrial education as it was then termed, though by this was meant the general education of those engaged in industry, not what we now know as technical education, the training of industrial workers in the subject matter of their trades.

The first efforts for the promotion of popular education in this country took the form of the establishment of Mechanics' Institutions. Their origin may be traced as far back as 1800, when Dr. Birkbeck, who had succeeded Dr. Garnett as Professor of Natural Philosophy at the Andersonian University of Glasgow, established courses of lectures, to which working men were admitted at a low fee. The mechanics' classes thus established were for a long time a successful department of the University, and in 1823 this department became the Glasgow Mechanics' Institution, apparently the first genuine institution of the sort.

The establishment of this institution suggested the formation of a similar organisation in London, where Dr. Birkbeck had been resident for about twenty years. He took the lead in the movement, and, with the assistance of Lord Brougham and others, established the London Mechanics' Institution, which later on became the well-known Birkbeck Institution, the name being changed in honour of its founder and first president.

The London and Glasgow Societies had many imitators, and in 1848 the Society passed a resolution that any such institution established not less than fifteen miles from London might join the Society for the same subscription as an individual, so that its members might enjoy, under certain conditions, the advantages of membership of the Society. A few institutions availed themselves of the offer, and a little later, in 1851, Mr. Harry Chester addressed a letter to the Council, suggesting that "the Society should exert itself to increase the efficiency of the metropolitan and provincial mechanics' institutes." The result of this letter was that the Society called together a conference on the subject, which was held in May, 1852, under the presidency of the Earl of Lansdowne. At this conference a union of institutions was suggested, and such a union was formed in the following July by a resolution of the Council. The object of the union was to enable the scattered institutions to co-operate, and thereby to increase their educational facilities. The intention of the Society was to provide a central organisation, from which information could be distributed to the institutions, lists of lecturers provided, and other facilities for their development arranged.

In addition to holding this conference, the Society issued, in 1853, a long report on "Industrial Instruction," which had been prepared by a committee appointed for the purpose. This committee took a great deal of evidence from schoolmasters, manufacturers, representatives of mechanics' institutions, and others, and the information they supplied forms the principal and the most valuable part of the report.

It was determined to hold an annual conference for the discussion of subjects relating to the institutions and their organisation, and such a conference was held at the Mansion House in May, 1853, by the then Lord Mayor, Mr. Thomas Challis, at the request of the Society, by which time 270 institutions had joined the union. In connection with this conference a small exhibition of educational appliances was held in the Guildhall, and this led to a proposal for a similar exhibition on a larger scale to be held in the following year, the centenary of the Society. The proposal was readily taken up. Prince Albert expressed his warm approval of it, and promised a subscription of £100. The accommodation on the Society's premises being quite inadequate for an exhibition on the scale proposed, St. Martin's Hall—a large concert hall, which had been built for John Hullah in Long Acre — was taken for the purpose.*

The exhibition proved to be a great success, and quite justified the very considerable amount of labour which was expended upon it by the Council. Contributions (through the assistance of the Foreign Office) were secured from France, Belgium, Holland, Sweden, Norway, Denmark, Austria, Prussia, Switzerland, Spain, and the United States. The exhibits included educational apparatus and appliances of all sorts,

* St. Martin's Hall was built in 1847–1850; it was No. 89, Long Acre. It was burnt down in 1860, and its destruction nearly ruined Hullah, who had invested most of his money in it. Later on, the Queen's Theatre was erected on the site, which is at present occupied by private premises.

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school buildings (shown in plans and models) and fittings, books, maps, etc., together with samples of work produced at schools. It was opened in July, 1854, by Prince Albert, and remained open until September. Arrangements were made for the delivery of lectures by the most eminent authorities on Science and Education. The list of lecturers included Dr. Whewell, Professor De Morgan, Dr. W. B. Carpenter, Dean Trench, Cardinal Wiseman, Professor Alexander Williamson, Professor Huxley, Dr. Hullah, and many other names of almost equal renown.*

Including the donation from the Prince Consort, the subscriptions amounted to £1,079. This involved a pecuniary loss of £363, which was made good by the Society. The success of the exhibition led to the suggestion that it should be made permanent, and this view was impressed by the Council upon the Government, with the result of the foundation of the educational collection and library at South Kensington as part of the Museum, now the Victoria and Albert Museum. A great number of the exhibits were presented to the new Museum, and formed the nucleus of the educational collection, and also of the fine library forming part of the Victoria and Albert Museum.

The conference of representatives of institutions became an annual function, and was continued regularly on the same day as the annual dinner, so long as the dinner was held. It lasted for a little over twenty years, until 1875, by which time its usefulness had quite passed away. In the following year it was changed into a special conference on Adult Education, at which Sir Henry Cole presided, and in 1877 its place was taken by a conference on Domestic Economy, held at Birmingham, at the suggestion of the same gentleman, who had by that time retired from the public service, and was then temporarily resident in Birmingham. After that the conference was allowed to lapse.

It would, indeed, have died out long before, but for the institution of the system of examinations, which has now for over fifty years been a very important part of the Society's work. It was in December, 1853, that Mr. Harry Chester, the founder of the Union, suggested the establishment of a system of examinations for the benefit of members of the affiliated institutions. The proposal was much discussed in the Council, by special committees, and at the meeting of the conference. It was at once generally approved, but it took some time before a satisfactory scheme could be evolved. A very strong board of examiners was appointed, and at first the control of the examinations was left in their hands. Divergent views soon made themselves evident, and there was some friction between the Board and the Council. Eventually, however, these matters were satisfactorily arranged, and a system devised for the concurrent holding of examinations at appointed centres all over the kingdom, a system which has not only worked well and smoothly for the Society's own examinations, but led to the larger system of examinations by the Government Department of Science and Art, and a little later to the University Local Examinations. It is unnecessary to say more here about the history of the examinations, because it has been dealt with in sufficient detail in a previous article in the *Journal*, which, originally contributed in the form of a paper by the present writer to the proceedings of the International Congress on Technical Education, held in London in 1897, has since been republished with additions in the *Journal.**

Probably the real value of the Union of Institutions was that it encouraged the establishment and development in provincial towns of educational organisations, which a little later provided suitable centres for the local science and art schools, and thus served as a basis for the whole system of education, scientific, artistic, and technical, which has grown up around those schools.

When the Society took in hand the organisation of local institutions some of them were flourishing and doing serious work, but many others were in a feeble condition. Such education as these latter afforded was of a trivial sort, and they were devoted rather to amusement than to instruction. The Society provided a standard to which all were expected to conform, and a central organisation from which all could get information and help.

After some twenty years or so the work of the Union was done, and there was no longer much need for its existence. When in 1882 the examination system was remodelled, and the examinations were thrown open to everybody, the last reason for its maintenance disappeared, and though there are still a few institutions which like to preserve their old association with the Society, it must be admitted that the

* Some of these lectures were published in a volume (Routledge, 1855). Others were reported, more or less fully, in the *Journal*.

* *Journal*, April 16th, 1909, Vol. LVII. p. 431.

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practical advantages they derive from that association are now inconsiderable.

It was the existence of the Union of Institutions that led to the establishment of the Society's weekly *Journal*. The first suggestion of such a thing was made by the Rev. Dr. Booth, in a letter which he addressed to the Council in June, 1852. In this letter he set out in considerable detail the scheme of a weekly newspaper which should record all the Society's proceedings, serve as a medium of communication between the Society and the allied institutions, and form a permanent record of the progress of science, art and industry. The proposal had evidently been thoroughly well thought out, and was, indeed, eventually adopted without any considerable modifications.*

As mentioned in a previous article of this series,† the *Transactions* of the Society had stopped in 1844, and from that time there had been no regular record of the Society's proceedings. The occasional publication first known as the *Abstract of Proceedings*, and afterwards, when it got to be published with greater regularity during the session, entitled *Weekly Proceedings*, had increased slightly in size, and it, at all events, recorded in brief abstract the papers read before the Society, and gave some amount of information about its other proceedings. This from 1844 to 1852 was the only publication regularly issued by the Society, for the odd volume of *Transactions* published in 1852, and intended to form the first of a new series, had no successor, and can only be regarded as an unsuccessful experiment, as it proved too costly for repetition. A volume issued in 1851, and entitled Vol. LVII. of the *Transactions*, is really nothing more than the weekly proceedings for the year bound together. Even the meagre record preserved in the *Weekly Proceedings* would not now be available but for the care of Davenport, who in November, 1852, presented to the Council a "volume containing a complete set of the papers published in the years 1844–9, during which time no regular transactions were published, and consequently no record of the Society's proceedings existed."‡ Davenport had no doubt carefully preserved a copy of each issue, which nobody else seems to have done, and his volume is the only set of them in the Society's possession.

Booth's suggestion commended itself to the Council, and after some discussion and consideration, it was accepted, the form of the *Journal* settled, and its regular publication commenced, the first number appearing on November 26th, 1852. This number, after a preliminary notice dealing with the proposed scope and character of the new publication, contained the address of the chairman (Henry Cole) at the opening meeting of the Session, an interesting account of the Industrial Societies of the United States, one of the replies (from British Guiana) to a circular asking for information about the productions and commerce of the Colonies; reports of the proceedings of many of the affiliated institutions, and a list of applications for patents under the new Patent Law Amendment Act of 1852. There are four pages of advertisements, but three of those are Society's notices. Succeeding numbers contain the papers read at the ordinary meetings—at first in abstract, and afterwards in full—with brief notes of the discussions, reports and notices dealing with the various matters on which the Council and the numerous committees were engaged, and much miscellaneous information on subjects connected with the objects of the Society. From the first the *Journal* was a newspaper, and was stamped with the newspaper stamp required at the time. This duty on newspapers was originally imposed by the Stamp Act of 1712, and, after several reductions, was finally abolished in 1853.

When the accounts of the 1851 Exhibition had been made up, it was found that there was a surplus profit of £186,000. Of this, however, £67,896 was the amount which had been subscribed before the Exhibition was started, and it was expected that this would be returned to the subscribers, or at all events given back to the various localities in which it had been subscribed. The Society, which had collected the money, also put in a claim for a share. However, it was decided that the money should be kept, and used for the foundation of a central institution "for the dissemination of a knowledge of science and art among all classes."

This caused a good deal of disappointment at the time, but, looking back at all the circumstances, it cannot be doubted that the decision was a wise one, and that better results have been obtained than if the money had been

* The Rev. James Booth, LL.D., F.R.S., was at this time Vicar of Wandsworth. His suggestion led to his being elected on the Council (1852), and he afterwards (1855) became its chairman. He took a very active and useful part in the establishment of the examinations, but later on some friction arose between the Council and himself, and after a quarrel, the details of which are certainly now not worth recording, he was called upon to resign his seat on the Council, and did so. He died in April, 1878.

† *Journal*, April 5th, 1912, p. 531.

‡ Council minutes, November 11th, 1852.

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frittered away by distributing it in comparatively small sums for provincial objects. Eventually, as is well known, the estate at Kensington Gore was purchased, and the 1851 Commissioners were formed into a permanent body for its administration. Many schemes were proposed and discussed. Prince Albert had a large and comprehensive scheme of his own, which included the erection of suitable buildings, and the transplantation of the principal learned societies to South Kensington. The idea was a fine one, and if it could have been carried out we might perhaps have had, years ago, a single comprehensive board or institution for dealing with education, science and art, instead of our present system, which, whatever its merits, cannot claim to be a model of organisation, economy or uniformity.

But there was much opposition, and there were many difficulties. The story is too long for repetition here. Those who care may find much of it in Sir Henry Cole's Life. It may be sufficient to say here that the immediate outcome was the South Kensington Museum and the Science and Art Department, with the foundation of both of which the Society had much to do.

The second report of the Commissioners of the 1851 Exhibition, published at the end of 1852, and reporting the purchase of the Kensington estate, referred, amongst other matters, to the formation of a trade museum, and invited the co-operation of the Society of Arts. The Council at once took the matter into consideration, and the result was that in May, 1853, they offered to undertake the formation of a collection of animal products used in manufactures, and to devote to it a sum of £400, to be expended in the course of two years, if the Commissioners would provide a similar amount. This was at once agreed to, and the formation of such a collection immediately put in hand. Professor Solly undertook its formation, and for that purpose resigned the secretaryship of the Society. He devoted himself energetically during the following two years to the work, and the result was that in May, 1855, a very complete collection was exhibited in the model room, and was formally opened by the reading of a paper by Mr. Solly. The exhibits fully illustrated the utilisation of animal products for industrial purposes, and comprised textiles (wool and silk), leather and furs, horn and bone, bristles, feathers, hair and shell, also wax and lac, oils, and, finally, refuse materials.

The collection, after being for some time exhibited by the Society, was made over to the Science and Art Department, and was placed in the South Kensington Museum, which was opened, in the temporary buildings for long known as the "Brompton Boilers," in 1857. As is well known, the original intentions of the 1851 Commissioners as to the formation of a trade museum were never carried out. The collection of animal products was transferred to the Bethnal Green Museum, when, new buildings having been built for the South Kensington Museum, the old "boilers," with certain additions, were re-erected at Bethnal Green.

The total amount expended by the Society, including the £400 originally granted by the Commissioners, was £976. On the transfer of the collection, the Commissioners agreed to repay the Society's expenditure, and the balance (£576) was accordingly repaid to the Society.

This collection and the educational collection previously mentioned were the chief contributions of the Society to the Museum. Both of them were valuable, not so much for themselves, but because they formed a nucleus out of which, by continual accretions, the scientific and educational collections now forming part of the Victoria and Albert Museum have grown. It must, of course, be understood that this does not refer to the Art Museum, to the contents of which the Society was never in a position to make any but trifling contributions.

As regards the Science and Art Department, the Society can only claim the credit of having done a good deal of pioneer work, and of having prepared the way for its establishment. Though Schools of Design* were started in 1839 or 1840, they were, by all accounts, not very successful, and in 1851 a vigorous attempt was made by the Society to encourage the formation of such schools on an independent basis. The proposal was well taken up in several provincial towns and in London, but in the following year the Department of Practical Art was formed by the Board of Trade, and this a year later became the Science and Art Department. It took over the existing Schools of Design, and there was no further need for the Society to persevere with its scheme, which was accordingly dropped.

Still more useful service was rendered the new Department by the Society's development of Mechanics Institutions and by its examinations. It was at these institutions that the

* They were not really Schools of Design at all. They were called so because they were imitations of the French *Écoles de Dessin*, and were simply, like the French originals, drawing-schools.

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Science Schools and Art Schools were first formed, and it was on the model of the Society's examinations that the much larger scheme of Government science examinations was carried out.

Before the opening of the 1851 Exhibition the Council announced the offer of prizes for essays or treatises on certain sections of the Exhibition. But before the time came for the award of these prizes, Prince Albert, in the autumn of 1851, suggested that a series of lectures should be given at some of the Society's meetings, "on the probable bearing of the Exhibition on the various branches of Science, Art, and Industry." This proposal was at once adopted, and the offer of prizes withdrawn.

In all twenty-four lectures were delivered during the session 1851–2,* and these were afterwards published in two volumes, which attained a considerable amount of popularity. The first lecture was given by Dr. Whewell, at the opening meeting of the session in November, 1851, and dealt with the general bearing of the Exhibition on the progress of Art and Science. Among the other eminent lecturers were Sir Henry de la Beche, on Mining, etc.; Professor Owen, on Raw Materials; Dr. Playfair, on Chemistry; Dr. Lindley, on Food Substances; Professor Willis, on Machines; Professor Royle, on the Arts and Manufactures of India; Sir Thomas Bazley, on Cotton; and Digby Wyatt and Owen Jones, on the Decorative Arts. The concluding lecture on the "International Relations of the Exhibition" was given by Sir Henry Cole.

Of the various exhibitions which were held by the Society in its own house many were the forerunners of the 1851 Exhibition, and it was out of them that the Great Exhibition eventually evolved itself. Reference has been made in a previous article to the announcement made in 1846 of prizes for designs "for useful objects calculated to improve general taste." This announcement was the result of an offer of £50 made "through the secretary" to the Council at its first meeting. As a matter of fact, the offer was made by Scott Russell himself. It has also been recorded how one of the articles sent in was the tea service designed by Henry Cole, and submitted under his well-known pseudonym of "Felix Summerly," which was manufactured, at his instance, by Messrs. Minton. It is because this offer of prizes led to the first exhibition of British manufactures, and because this first exhibition gradually led up to the 1851 Exhibition, that it has been said that "Felix Summerly's" teacup was the origin of the Exhibition.

The response to the first offer of prizes was but meagre. Nevertheless, it was renewed in the following year (1847), and it was the prize articles of 1846, together with the articles sent in in competition in 1847, which formed the basis of the Society of Arts' first exhibition of "select specimens of British Manufactures and Decorative Art," which was opened at the Society's house in March, 1847. The exhibition itself would have been but a poor one had it not been supplemented by examples lent at the urgent solicitation of Henry Cole, Scott Russell, and another member of the Society, who, as Russell himself afterwards said, spent three whole days travelling about London in four-wheel cabs calling on manufacturers and shopkeepers, till they had at last succeeded by personal entreaty in inducing some of them to send sufficient goods to fill the exhibition room. In the event, however, the exhibition turned out a complete success, and it was visited by 20,000 people. Still greater success attended a repetition of the experiment in 1848, for manufacturers began to realise the advantage of the cheap advertisement provided by exhibitions. This second exhibition was attended by over 73,000 visitors, and for the third, in 1849, the accommodation on the Society's premises proved quite inadequate. Even more successful was the exhibition held in 1850 "of works of Ancient and Mediæval Art." The success of this exhibition was due to a large extent to the exertions made by Mr. (afterwards Sir) Augustus Wollaston Franks, the eminent archæologist, who in later years was the head of the British Museum Department of British and Mediæval Antiquities, etc. He acted as honorary secretary to the exhibition, and took infinite pains to ensure its success. This attracted even more public attention than the exhibitions of manufactures. Collectors, who had not then the numerous applications for loans to which they are now subjected, were liberal, and generously lent many objects of interest and value. The newspapers at the time were full of accounts of the exhibition and its contents.

As before said, these exhibitions led up to the international one of 1851; but the Society went on holding exhibitions on its own account. In 1848 an exhibition of recent inventions was held. This was composed partly of objects belonging to the Society's own collection, which

* Sir H. Cole's lecture had to be postponed, and was delivered in December, 1852.

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had not then been finally disposed of, and inventions recently patented or registered under the Designs Act of 1851. This exhibition was a fairly good one. It contained 446 exhibits in all, of a rather miscellaneous character, some however of permanent interest and value. It remained open from December 26th, 1848, to January 30th, 1849. It was the first of an annual series continued regularly up to 1861. By that time its character had depreciated, and Sir Thomas Phillips, in the address which he delivered as Chairman of the Council in November, 1862, remarked that "the series have not kept pace with the progress of science, and have not been worthy of the present position of the Society." It was determined, in consequence of the 1862 Exhibition, not to hold an exhibition of inventions that year, and the opportunity was taken of letting the series come to an end.

Besides these exhibitions of an industrial character, the Society organised several exhibitions of pictures. As mentioned in a previous part of this article, the first action taken by Henry Cole in connection with the Society was the submission of a proposition for the holding of exhibitions of pictures by modern artists, in the hope that they would be a source of profit, from which funds might be provided for the establishment of a National Gallery of British Art. The proposal was that the profits from the exhibition of each artist's works should be expended in purchasing one or more of his pictures, and that these should be lent to the National Gallery, until enough had been collected to fill a special gallery. The idea was an admirable one. But the means proposed were quite inadequate, and, in spite of the enthusiasm which Henry Cole devoted to the scheme, it proved financially an absolute failure. The proposed series was started with an exhibition in 1848 of Mulready's works, the original idea of beginning with a collection of Landseer's not having for some reason been carried out. The financial result of the Mulready Exhibition was a small surplus, which was later on expended in the purchase of two of the artist's studies, and these were presented to the National Gallery. In 1849 an exhibition of Etty's works was arranged. But this resulted in a loss, and the idea of making money for the proposed gallery was abandoned. In fact, the Society was a heavy loser, for the expenses were ultimately paid only by the diversion, with the donor's consent, of a gift of £500 from Mrs. Acton, the widow of a member, which had been intended for the general purposes of the Society.* Some years later, in 1855, an exhibition of the works of the two brothers John and Alfred Chalon (both R.A.'s) was held, but it does not appear that this had any connection with Cole's scheme.† After the death of Sir William Ross, an exhibition of his miniatures was held in the Society's rooms in 1860, which attracted a good deal of interest, but did not produce any profit. Ross, as may be seen by reference to the list of the Society's prize-winners,‡ took many of the Society's prizes as a youth. He was long a member of the Society, was Chairman of the Committee of Fine Arts, and a member of the first Council.

It may be sufficient to mention that an exhibition of lithography was held in 1847, one of bookbinding in the same year, and a second of lithography in 1853. The photographic exhibition of 1852 will be referred to later, and the educational exhibition of 1854 has already been mentioned. In the year 1852 the idea was started of holding an exhibition of the products of India. The East India Company was approached, and promised assistance, and some steps were taken for organising such an exhibition in London. Eventually, however, there were difficulties in finding a suitable locality, and the collection was sent to the Dublin Exhibition of 1853, of which it formed an important section.

Since the first exhibition held by the Society in 1761 of agricultural and other machines for which the Society had offered prizes, it had always kept up a permanent collection of mechanical and other models. As these accumulated from time to time, their disposal was always a matter of difficulty, and every now and again we find notices of the older models, for which it was difficult to find room, being sold, or given away, or destroyed. Many of these one may legitimately regret. It would have been satisfactory if the original model of Sturgeon's electro-magnet had been preserved, and we should certainly be glad to possess now the whole collection which was shown in 1761.

But it must be remembered that such things accumulate rapidly, and that they soon become

* Mrs. Acton gave this money in 1837 to found prizes in memory of her husband, Samuel Acton, an architect, the prizes to be generally for subjects connected with architectural design or construction. She herself became a member after her husband's death.

† It is stated that this exhibition did not attract much attention, the works of the Chalons never acquiring much popularity.

‡ *Journal*, June 14th, 1912, p. 750.

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obsolete and uninteresting; while they have to be kept for a great many years before they acquire antiquarian interest—an interest, indeed, which only belongs to the few survivals out of the great mass. When the Society began to hold temporary exhibitions, the space occupied by the old models was required, and they were finally disposed of in various ways. The bulk of them were presented in 1850 to Bennet Woodcroft, who was then Professor of Machinery at University College, London, the trustees of the College having undertaken to repair and preserve them.* Some of these eventually found their way into the Patent Office Museum† at South Kensington, which grew into the collection of engineering models now forming part of the Science Museum. Others were given to the South Kensington Museum at its foundation in 1857, and no doubt a great deal of what was really rubbish was quietly disposed of. The valuable collections of woods presented by Dr. Wallick in 1831 and by Captain Baker in 1834‡ were given to Kew in 1851.

Reference has already been made to the injurious effects on the Society's Premium List of the exclusion of patented articles from its awards, and the alteration in the regulations by which in 1845 patented articles were made eligible for such awards has also been mentioned. Not very long after this date, the Society, taking a different view of the value of patents, turned its attention to the amendment of the patent law, and in 1849 the Council, at the instigation of Henry Cole, appointed a Committee on the Rights of Inventors. It cannot be said that Cole had any deep or accurate knowledge of patent law; but he had on this, as on most subjects which he took up, very clear and definite ideas, and he never hesitated as to their correctness. The committee, however, which was appointed by the Council, included many members who were quite competent to supply any deficiency in Cole's knowledge, and he provided the moving force, which eventually brought about the much-needed reform in the law of patents in this country.

About a year after the appointment of this committee, Charles Dickens published in *Household Words* his well-known "Poor Man's Tale of a Patent"*; this, by the public attention it attracted to a very dull and uninteresting branch of legislation, greatly aided in securing the required reform.

The committee published several reports—reports containing many suggestions of considerable practical value. The general tendency of the reports was rather in favour of the French system—simple registration, *sans garantie du gouvernement*—a principle which has commended itself to a great many authorities on Patent Law. As a matter of fact, this has always really been the English system, which, while professing to be a grant direct from the Crown of an important monopoly, is, as has often been said, nothing except a license to go to law, and a registration of the date on which the inventor might commence his action. The logical French mind naturally agreed to a simple statement of the facts as they were. But the Englishman preferred something which appeared a great deal more important, professing, as it did, to be a grant direct from the Crown, although the imposing document, with the Great Seal attached to it, actually gave no more right than would have been conferred by a simple entry in a ledger. On the other hand, it has to be remembered that an invalid patent, which could not be maintained for a moment in any court of law, is often extremely valuable as a scarecrow, warning off trespassers from a territory to which the professed owner has no legal right, and this, perhaps, is after all the reason why the pretentious but illogical British system has so long been maintained.

In America and in Germany the opposite ideal has prevailed, and the attempt is made to provide a patentee with a genuine monopoly, by certifying to the originality of his ideas. The system in America used, if all tales be true, to be modified by the friendly relations existing between the patent agents and the officials, though no doubt this is no longer the case; while the German carried out his ideas to the utmost, and reduced them *ad absurdum* by such cases as refusing Siemens a patent for his regenerative furnace on the ground that it was anticipated by a mediæval oven, in which bread was baked after the material by which the oven had been heated was removed.

Whatever may be the best of these two opposite systems and ideals of patent law, it

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* *Transactions*, Vol. LVII. p. xvii.

† The contents of this museum were the property either of the Commissioners of Patents or of their clerk, Woodcroft. They were to have been placed in the principal museum building, but Woodcroft objected to the admission fee of sixpence on "Students' days." Cole insisted, and neither would give way. The result was that the models of inventions were crowded into an unsightly iron shed, which was always open free to the public. So the authorities had their way, and nobody suffered except the public.

‡ *Journal*, September 29th, 1911, p. 1040.

* *Household Words*, October 19th, 1850.

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may suffice to say here that the view of the Society's committee was not adopted when the Bill, which in 1852 became an Act, for the reform of the Patent Law, was introduced into the House of Commons; but many of the other provisions were, and many parts of the Act were founded on the Society's suggestions. This Act, which came into force on October 1st, 1852, introduced many and great changes in the system for granting patents. It abolished the "hanapers" and "chaffwaxes," whom Dickens had held up to scorn; it simplified procedure, and reduced cost. It continued to be the law for many years, as it was not until 1883 that any important alterations were made, and in that later reform the Society, as may hereafter be recorded, had its due share. For the present, the work of the committee having been more or less satisfactorily accomplished, no further action was taken, and it was not reappointed after the passing of the Act.

The natural result of the new Act was an enormous increase in the number of patents applied for, and a consequent considerable revenue to the Patent Office. In the course of a few years the amount of patent fees had totalled up to a large sum, and suggestions began to be made that money provided by inventors ought to be applied in some way for their benefit, instead of being added to the public revenue. Sir Joseph Paxton, in 1856, addressed a letter to the Council on the subject, and the result was a committee, and a memorial to the Commissioners of Patents. Nothing, however, came of it, though the Commissioners seem to have been sympathetic enough, for they published year after year in their annual report a sort of mute appeal to the Treasury in the form of a statement of the accumulated surplus income they had earned. The last time this statement appeared was in 1881, in their report for the previous year. At that time the aggregate surplus income from October 1st, 1852, to the end of 1880 was £2,041,159 16*s.* 10*d.* The Treasury, however, were deaf to the appeal, and apparently saw no reason to abandon so convenient a source of revenue.

In December, 1852, an Exhibition of Photographs was arranged by the Society. This was the first public exhibition of photographs which had ever been held, though a few specimens had been exhibited in the Philosophical Instrument Section of the 1851 Exhibition. One hundred and twenty-nine pictures were shown, nearly all of them by the paper processes, though there were some collodion positives. At that time collodion had not been applied to the production of negatives, though a few months later (July, 1853) it was found that the picture on the collodion film on glass could be employed as a negative, and from that time forward it was so employed, to the ultimate exclusion of the earlier methods, in which paper rendered transparent by wax or other means had been used.

The formation of a Photographic Society was first proposed by Mr. Roger Fenton in April 1852, and in the same month Mr. Robert Hunt applied to the Society, asking for the use of the meeting-room for an inaugural meeting to establish such a society. The request was granted, but the meeting was not held until January, 1853. At this meeting Le Neve Foster, who had previously obtained the sanction of the Council to his suggestion, brought forward a proposal that instead of forming an independent society, a special section of the Society of Arts should be established dealing with photography. This proposal, however, did not meet with the approval of the photographers present, who were strongly in favour of an independent organisation, and the Photographic Society of Great Britain was established on January 20th, 1853. Sir Charles Eastlake, then President of the Royal Academy, became the first president of the new society. This, the earliest of all photographic societies, became the parent of many other similar bodies in this country, and its example was also soon followed in other countries.

The question of copyright in works of Art was taken up in March, 1858, when a committee was appointed by the Council to inquire into this subject. Of this committee Sir Charles Eastlake, then President of the Royal Academy, was appointed chairman, and he held the post until the termination of its work four years later. At that time there was almost no copyright in works of Art. The only Act in which any protection at all was given them was that known as Hogarth's Act (8 George II. c. 15), passed in 1735. It was connected with the name of Hogarth because it was obtained by him, mainly at his own expense, in order to protect his engravings, from the piracy of which he suffered considerable loss. There had been several amending Acts, but none which gave the author of an original work of Art the power of preventing its being reproduced and copies being sold.

The committee drafted a Bill to establish copyright in works of Fine Art, and this was introduced in the Session of 1860. In spite, however, of all the pressure that the Society

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could bring to bear, by deputations to the Government, petitions, and otherwise, the Bill was not passed until July, 1862, and then only in an emasculated form, because the promoters were obliged to abandon its more important provisions in order to get the Act passed at all. Nevertheless, it was a very important reform, and it continued for many years to be the law on the subject. It established the existence of a copyright in works of Art, though, owing to the way in which one of the clauses was drafted, it made it rather uncertain as to whom the copyright should belong to in cases in which the artist had executed the work for a valuable consideration, or also if he had disposed of the work itself without either retaining or transferring the copyright. In spite, however, of its admitted imperfections, it worked fairly satisfactorily, and though it has been adversely criticised, it was at the time a great and valuable advantage to artists.

Its main provisions have been preserved in the most recent legislation on the subject, the Copyright Act (1 and 2 Geo. V. c. 46) passed in the Session of 1911, and in force since July 1st of the present year.

In 1859 the Society, at the suggestion of Wentworth Dilke, who was then the Chairman of Council, took up the question of musical pitch. The French standard pitch, then and since known as the Diapason Normal, became legal in France on July 1st, 1859; and it was no doubt the fact that the French had adopted a musical standard that led to the endeavour in this country to follow their example. The proposal that an attempt should be made to standardise musical pitch in this country was referred to a meeting of musicians, and after this a committee was appointed, which produced a very comprehensive and valuable report drawn up by Dr. Hullah.*

On the recommendations of the committee, a standard was suggested of 528 vibrations for the middle C of the pianoforte. The French Diapason Normal was 435 for the corresponding note A, and the Society's note A would then be 440; but instead of this, A was made 444 vibrations on the equal temperament system.

It is certainly unfortunate that the Society's committee did not adopt the just A 440, which would have been near enough to the French pitch for the two to have been treated as practically identical, and the probable result would have been that the French pitch would have been adopted in this country, and we should have got a uniform musical pitch many years ago. The question was further complicated by the fact that Mr. Griesbach, a musician who had concerned himself with experimental acoustics, and who had been entrusted by the Society with the tuning of the standard forks, unfortunately was incorrect in his determinations. His C fork was 534·5, instead of 528, and his A fork 445·7, instead of 444.*

The Society's well-intentioned and well-directed efforts had no practical result, and the suggested pitch was never to any extent adopted here or elsewhere. Much later on its existence became one of the obstacles to the adoption in this country of a standard pitch, and in 1886 it was referred to a committee to consider whether it was still desirable for the Society to maintain its theoretical C 528. On the advice of this committee, the Council in February, 1886, formally abandoned the Society of Arts pitch, and published their reason for so doing.†

The committee further advised that the Society in abandoning its own pitch should use its influence in furthering the adoption of the French pitch, from which, as before said, the Society's pitch, when accurately measured, did not really differ very much.

One of the schemes taken up by the Council aroused a great deal of ridicule, although it provided for what has now got to be considered as one of the necessaries of civilisation—that is, the supply of public water-closets and lavatories. Such conveniences had been arranged for in the 1851 Exhibition, and the charges made for their use resulted in a small profit.‡ It was thought, very properly, that similar conveniences ought to be provided in all great cities, and Sir Samuel Morton Peto, the well-known contractor, offered to defray the cost of the experiment, if the Society of Arts would undertake to provide waiting-rooms with suitable accommodation in London. Arrangements were made for two such places—one for gentlemen in Fleet Street, and one for ladies in Bedford Street, Strand.

The experiment turned out a complete failure, as the cost of establishment and current expenses for a period of about six months amounted to £492 17*s.* 4*d.*, whereas the total

* The report was printed in the *Journal* for June 8th, 1860, Vol. VIII. p. 572.

* These particulars are taken from a most interesting paper by Mr. A. J. Hipkins, read before the Society, in February, 1896, and published in the *Journal*, Vol. XLV. p. 535.

† *Journal* for February 12th, 1886, Vol. XXXVI. p. 265.

‡ The receipts were £2,470 and the expenses about £680. *Transactions*, Vol. LVII. p. xvii.

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receipts were only £15 13*s.* 11*d.* Mr. Peto (as he then was) paid up the balance of £477 3*s.* 5*d.*, and the experiment was brought to an end. It, however, served its purpose in drawing attention to the necessity for such places. Later on the matter was taken up by the City Corporation, mainly owing to the recommendations of William Haywood, the City engineer (1846–1894), who originated the system of underground lavatories; and now London, which fifty or sixty years ago was probably the worst supplied of any capital in Europe with sanitary conveniences, is certainly the best.

Although the Society had long since given up the practice of making the bestowal of premiums its chief object, it never wholly abandoned that practice. Reference has been made more than once to the special prizes which were given during the years which preceded the 1851 Exhibition, and, indeed, gave the first stimulus to the idea of such an exhibition. The award of these special prizes was carried on from 1846 to 1850, and during that period the following well-known firms, amongst others, received the Society's medals:—Minton & Co. and Copeland (pottery); Osler & Co. and Pellatt & Co. (glass); Woollams & Co. and W. B. Simpson (paperhangings); the Coalbrookdale Co. (iron castings); Hunt and Roskill (jewellery); Crossley (carpets); Chubb (safes); and Leighton (bookbinding). Mention should also be made of the gold medal awarded to W. C. Siemens in 1850 for his regenerative condenser. This was an early and not very successful application of the regenerative principle. It was included in the patent for a regenerative engine (1847), and was the subject of a later patent (1849). The regenerative furnace was patented by Frederick Siemens in 1856.* Many years afterwards, when he occupied the post of Chairman of Council, Sir William Siemens said that this prize, the first he ever received, had been of the greatest encouragement to him. In the same year Henry Bessemer also had a gold medal for one of his minor inventions—a sugar-cane press. His improvements in steel manufacture were, of course, of a later date, his first patent connected with the "Bessemer process" having been taken out in 1855.

Inasmuch as the Society never formally discontinued its practice of awarding medals for meritorious inventions, it was always open to anybody to submit anything which he considered worthy of award, and from time to time new inventions of various sorts were so submitted, referred to a small committee or some individual expert, and received prizes. The publication of a premium list was also continued, and from time to time such a list was issued. It was of a very miscellaneous character, and produced but small results. The last list of this sort appeared in the *Journal* in 1873, but no awards, or very few, were made upon it.

During the period with which we are now engaged some special prizes of importance were offered. The Society's colour-box has already been mentioned.* This was the most popular of all its awards. The most important was the one offered for a microscope. In the summer of 1854 Dr. W. B. Carpenter suggested to the Council that a prize should be offered for a cheap microscope, the cost of such instruments being then such as to put them out of the reach of students and teachers of elementary science. The proposal was approved, and on the recommendation of a committee of microscopists, two medals were offered, one for a simple and one for a compound microscope, to be supplied at the price of 10*s.* 6*d.* and £3 3*s.* respectively. It was said that at such prices nothing of any practical use could be provided, but Messrs. Field, of Birmingham, produced two excellent instruments at the stipulated price, and the prizes were awarded to them. In the simple microscope, a tubular stem, which screwed into the top of the box containing the instrument when not in use, carried an inner rod fitted with a rack and pinion, and on this rod the lenses were mounted. There were three lenses, giving separately or in combination a range of magnification from above five to forty diameters. The top of the stem carried a stage, to which could be fitted a condensing lens for illumination or a stage-forceps. The little instrument, which was sold for 10*s.* 6*d.*, was well suited for the examination of botanical and other natural history specimens. In construction and design it seems to have been quite novel at the time.

The compound microscope was a really excellent instrument. It had a cast-iron stand, very firm and steady, two eye-pieces, two objectives giving a range from 25 to 200 diameters, a stage with rotating diaphragm, coarse and fine adjustments, adjustable mirror with plane and concave sides, separate condenser, stage-forceps and live-box. It was not, of course, an instrument suited for scientific research, but it was

* "Life of Sir William Siemens," by William Pole (1888), p. 75 *et seq.*

* *Journal*, June 21st, 1912, p. 764.

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a thoroughly serviceable one, and nothing like it had ever before been produced at such a price. Dr. Carpenter, in his well-known book on the microscope, speaks highly of it, and in his third edition, published in 1872, he says that by the end of the year 1861, 1,800 instruments had been sold.

The principal value of the award was that it proved that a serviceable microscope could be produced at a cost far lower than that of any previous instrument, and the natural result followed that it had many successors, some of them improvements on the original, though perhaps there were none which competed with it in price. Certainly more than twenty years after its introduction microscopes were being sold which professed to be the Society of Arts pattern, and resembled it more or less closely both in character and merits. Later still, of course, much greater improvements were made, especially in the optical part, and inexpensive microscopes can now be bought compared with which the original Society's microscope is but a very inefficient tool. But it remains the first of its sort, and its introduction was a great boon to the scientific student of fifty years ago.

In 1857 Mr. John MacGregor offered the sum of £10 for a prize for a cheap writing-case suitable for the use of soldiers and sailors. The donor was well known as "Rob Roy" MacGregor, from his having invented what he called the "Rob Roy" canoe. This was a canoe rather larger than the double-paddle canoes which were then coming into fashion, covered in fore and aft, and capable of standing heavier weather than the ordinary canoe. MacGregor made various voyages in his favourite craft, including one down the Jordan (1868), which he described in a book that attracted a good deal of attention at the time. MacGregor's offer being considered insufficient, it was supplemented by a donation of an equal amount from the Rev. F. Trench, and the full prize of £20 was awarded in 1859 to Messrs. Parkins and Gotto for a writing-case which was sold at the price of 1*s.* 6*d.* It achieved a considerable amount of popularity, for 20,000 of them were sold; but its chief use was, like that of the colour-box and microscope, that it was succeeded by various forms of cheap desks and writing-cases, which were improvements on the original, and were sold at an almost equally moderate cost.

In addition to these there were several prizes for essays. In 1853 a prize of £50 was awarded to James Hole, of Leeds (Honorary Secretary to the Yorkshire Union of Mechanics' Institutions), for an essay on Mechanics' Institutes. To this reference has already been made.

In 1855 a prize of twenty-five guineas, offered by Benjamin Oliveira, M.P., was awarded to Charles Wye Williams for an essay on "The Prevention of the Smoke Nuisance," and two years later, in 1857, a prize of £200, which had been offered by Henry Johnson for an essay "on the present financial position of the country," was awarded to Edward Capps.

It should be added that in 1850 Scott Russell made a suggestion that medals should be given to the readers of the best papers every year. The suggestion was adopted and at once acted upon. The practice has been continued from that date down to the present time.

As the first award of the Swiney Prize was made in 1849, this would seem to be the proper place to insert some account of this curious bequest.

At the meeting held on February 7th, 1844, Arthur Aikin reported that during his secretaryship thirteen years before, which would mean some time in 1831, "a stranger called at this office and put into my hand the will of Dr. Swiney, sealed up in an enclosure, and immediately left." Dr. Aikin endeavoured to find out the doctor's address, but without success. When he retired from the secretaryship (1839) he took legal advice as to what had better be done with the packet, and was advised to open it, when he found a note from Dr. Swiney addressed to himself, expressing a wish that he should take charge of the will. This note was dated from Sidmouth Street, Gray's Inn Road, but no trace of Dr. Swiney could then be found, though inquiries were at once made.

Aikin handed over the will to William Tooke, the Society's honorary solicitor, and it remained in his hands until January, 1844, when Aikin was summoned to attend at Dr. Swiney's lodgings in Grove Street (now Arlington Road), Camden Town, where he had died on January 21st.

On the will being read, it appeared that the deceased had bequeathed, amongst other legacies, £5,000 Three per Cent. Consols to the Society of Arts, and a like amount to the British Museum, on the condition, so far as the Society of Arts was concerned, that a sum of £100 contained in a silver cup of the same value should be awarded on every fifth anniversary of Dr. Swiney's death as a prize to the author of the best published book on Jurisprudence.

Not a great deal has ever been found out about

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Dr. George Swiney. He was said to be a son of Admiral Swiney, and a relation of Sir Humphry Davy. He was about fifty when he died, and had resided in Grove Street for about fifteen years. He was an M.D. of Edinburgh, where he graduated in 1816. He was certainly an eccentric character, and it was thought that some of his relations—for he appears to have had some — would have disputed the will. Nothing of the sort was done, and in due course the Society received its bequest. His eccentricity was displayed in the provisions made in his will for his funeral. These were all duly carried out. His coffin was covered with a yellow velvet pall, and followed by three girls in gay dresses. So curious a procession naturally attracted a great deal of attention, and the crowd was so great that there was some difficulty in carrying out the funeral. He was buried in the burial ground in Pratt Street, Camden Town. His tombstone having fallen into disrepair, it was twice repaired at the cost of the Society, the second time in 1899, when the old stone was in so bad a condition that it was thought best to renew it entirely and re-cut the inscription, which runs as follows:

HIC JACET
GEORGIUS SWINAEUS, MED. DOCT.
ANGLUS, SCOTUS, ET HIBERNICUS.
VIXIT SIMPLICITER
LUBENS OBIIT
12 KAL. FEB. MDCCCXLIV.
ANNO AETATIS SUAE L.*

Although the bequest was made to the Society of Arts alone, the adjudicators were, by the terms of the will, to be the members of the Society and the members of the Royal College of Physicians, "with the wives of such of them as happen to be married." It may be supposed that it was his connection with medicine which led him to drag in the College of Physicians; but it is only another proof of the man's eccentricity that on deciding to found an award connected with Jurisprudence he should select as adjudicators the members of two institutions neither of which has any connection with the law, or their members any special qualifications for the task. It, therefore, became desirable to consult with the College of Physicians as to the disposition of the prize, and before the time for the first award came round, the Council communicated with the College, with the result that an arrangement was arrived at that the award should be given alternately for General and Medical Jurisprudence. This arrangement has been amicably adhered to up to the present date.

When the question of designing a cup arose, Daniel Maclise was invited to submit a design, which was approved and accepted by the Council in May, 1849, the execution of the design being entrusted to Messrs. Garrard, the silversmiths. On two occasions since—in 1856 and 1894—the question has arisen of substituting a new design for that of Maclise, and the Council on both occasions went so far as to offer prizes for such a new design. In neither case, however, was the result satisfactory, and the cup is now, with some trifling alterations, the same as that originally designed by Maclise.

Besides the various matters already mentioned to which the special attention of the Society and its Council was directed, there were many other topics of which little more than bare mention must suffice.

In 1854 a Committee on Industrial Pathology was appointed, of which the most important members were Dr. T. K. Chambers and Mr. (afterwards Sir John) Simon. This Committee produced two reports.* Dr. Chambers also read a paper on the subject in June, 1854. In this paper,† and in the first report of the committee, the subject was dealt with in a general manner. The second report had special reference to trades which affected the eyes. Nothing very much seems to have come of the committee's efforts, and, indeed, this important subject hardly met with adequate treatment at the Society's hands.

The question of cheap international postage was taken up as early as 1851, and in 1852 the Council sent a deputation to Lord Granville, then Foreign Secretary, on the subject. In 1855 a parcel post was proposed for the first time. A committee reported on the proposal, and there was much discussion upon it, which bore fruit eventually, but not for many years.

The effects of the Paper Duty came under consideration from time to time, first in 1853, when the Council undertook an elaborate investigation into the effect of the duties, and collected the opinions of those whose interests were affected by them, including paper-makers, stationers, publishers, newspaper proprietors and editors, authors and traders using paper for manufacturing and other purposes A considerable amount of information collected from

* A few further details will be found in two articles in the *Journal*, Vol. XLVII. p. 660, and Vol. LVII. p. 440.

* *Journal*, Vol. II. p. 364, and Vol. III. p. 119.

† *Ibid.*, Vol. II. p. 401.

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these various classes was published. In 1860 a petition against what was called "taxes on knowledge" was addressed to the House of Commons. The duties were abolished in 1861, after a dispute between the two Houses of Parliament.

It is curious to note that when a proposal for national holidays was brought up before the Council in 1861, a resolution of disapproval was passed.

The centenary of the Society occurred in 1854, and was duly celebrated by a dinner at the Crystal Palace, at which Earl Granville presided. The Society's annual dinner was continued regularly up to 1862, when Mr. Gladstone was in the chair. This dinner was held in one of the refreshment rooms of the 1862 Exhibition building. Two years previously Mr. Disraeli presided. Other chairmen had been the Duke of Argyll, Lord Ashburton, Lord Stanley, the Earl of Carlisle, Lord Napier, and the Earl of Elgin. The numbers attending the dinner had gradually fallen off (there were 750 in 1854), and after 1862 it was not continued.

It is worth mentioning as a matter of record that the present Common Seal of the Society dates from 1856. It was adopted by a resolution of Council passed on June 18th in that year, and the old seal, with the design by Cipriani, which had been adopted in 1848, was given up.

When the Council met for the first time in December, 1845, the Society was not far from being bankrupt. All the available stock had been sold, and only a few trust funds, amounting to just £1,000, were left. The receipts for the year were insufficient to meet the annual expenditure; there was just £117 in the bank, and the Society was about £1,000 or so in debt. The accounts are not very clear, but that seems to have been about the actual state of the finances. It was obvious that if the Society was to go on at all, money had to be provided. Various plans were considered. Among other expedients suggested was the raising of a loan fund amongst the members. Various liberal offers were made to contribute to such a fund without requiring any interest, and several hundred pounds were thus paid, or promised, by some of the members. These contributions kept things going for a year or two, and then the Council received an offer from one of the members, Mr. Henry Hobhouse, to lend the Society a sum of £1,000 at $4\frac{1}{2}$ per cent. interest, to be secured by a debenture on the Society's property. This offer was gratefully accepted in May, 1848. It enabled temporary difficulties to be tided over, and in a year or so from this time the Society became practically solvent, the receipts from the increasing number of members and other sources being just about enough to balance the expenses. Still, when Mr. Hobhouse died in 1854 and his executors required the debenture to be taken up, the Council were not yet in a position to discharge the liability, but Mr. Thomas Twining, who was then a member of the Council, advanced £1,000 in the following year to pay Mr. Hobhouse's estate. This amount he was repaid in three instalments, the last in December, 1857.

The 1851 Exhibition and the growing reputation of the Society caused a large influx of members, and a similar result accrued from the Exhibition of 1862, so that the balance-sheet for the year ending June, 1862, showed a total of actual revenue of nearly £9,000, and a balance of income over expenditure of more than £1,000. The moneys in hand, and the amounts actually due and recoverable, were much more than sufficient to balance the actual liabilities.

That the actual financial condition of the Society was not generally appreciated, or its independence of official support generally known, is shown by an order made by the House of Lords in 1856 for a return of the sums of money granted by Government to the Society during the five years ending April of that year. The officials of the House, unable to supply the information themselves, applied for help to the Society, whereupon the Council directed the Secretary to reply that the Society had existed for over 100 years, and had never received any public money whatever, and that, therefore, the amount in question was "nil." There does not appear to have been any further correspondence. If the question were repeated at the present date, the same answer would serve.

When all the arrangements for the 1862 Exhibition had been successfully completed and the Society, then in the full tide of prosperity and success, was looking forward to the realisation of a considerable financial endowment from the anticipated profits of the Exhibition, their hopes were suddenly destroyed by the sudden and unexpected death of their President. The Prince Consort died in December, 1861. Though it was decided that the Exhibition should still be held, it was held during a period of national mourning, and without any of the pomp and circumstance which are essential to the success of such an undertaking. The result was a financial failure, which was only saved from disaster by the liberality of the contractors, who

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took upon themselves the main burden of the loss.

But the loss of prospective revenue was not the greatest of the Society's deprivations. For eighteen years Prince Albert had been the active and watchful President of the Society. He had taken office when its fortunes were at their lowest ebb, its members few and falling away, its resources exhausted. If he had not consented to accept the Presidency, a very few more years would have seen its extinction. When he died it was flourishing and rich, the number of its supporters was just as many thousands as it had been hundreds, and it had accomplished an amount of public work of which any institution might have been proud. To attribute all this to the Prince Consort alone would be the merest sycophancy; but it is absolutely certain that but for his influence and his inspiring interest the work would never have been done. At his last appearance at the Society, when, in May, 1861, he presided at one of its meetings, he expressed his regret that of late he had been unable to give to its work the attention and the care he had given in earlier years. The Society of Arts was one of the first public institutions in the country to which he lent his patronage and his help. It repaid his attention by being amongst the first public bodies in England to appreciate him at his true value. For years he was unappreciated, misunderstood, unpopular; but by the members of the Society with whom he worked in pursuance of aims and objects on which his heart was set, he was from the first appreciated, understood and esteemed. It is something to the credit of the band of workers who used the organisation of the Society for the promotion of much public good, that they estimated at its true value the character of a man who for long was too apt to be depreciated by his adopted countrymen, and whose genuine worth was only fully known in the closing years of his life among them.

When the question of a national memorial to the Prince came under consideration, the Council at once voted what was — considering the Society's resources—the very large sum of £1,000 towards it, and also took steps to collect subscriptions among the individual members. Yet to many outside the Council this seemed insufficient, and a proposal was put forward for a separate special memorial of the Society's own. This was at first opposed by the Council, who were aware of the Queen's desire that the monument to her late husband should be the result of a single united national effort. The feeling, however, was too powerful. An influentially-signed memorial was presented to the Council calling on them to summon a second general meeting—one had already been held to endorse the action of the Council in contributing from the Society's funds to the national memorial—and the Council, submitting to the evident wishes of the members, at once abandoned all opposition and took the lead in the proposed movement. The result was that a fund was subscribed by the members, out of which were provided the two portraits of the Queen and of the Prince now in the meeting-room, and the bust of the Prince now in the ante-room.

A still finer memorial of the Prince is the Albert Medal founded in 1863, "for distinguished merit in promoting Arts, Manufactures, and Commerce," and awarded for the first time in 1864. This was established by the Council in pursuance of a suggestion made at the general meeting above mentioned, and is, of course, provided at the cost of the Society.

It has been awarded annually since it was first founded. Next year will complete a half-century of awards. The list of its recipients forms a complete record of the greatest of those who during that period have laboured to apply the advances of science to the practical benefit of mankind. Their names are fitly associated with that of the earnest philosopher and philanthropist, to commemorate whose association with the Society the medal was established, and while the renown of the recipients adds a constantly increasing value to the honour of the award, the services recognised by the medal may fitly be held to lend some further lustre to the reputation of the sagacious and benevolent Prince in whose memory it was founded.

SCOTTISH AGRICULTURAL CHANGES.*

As a sphere of agricultural production, Scotland offers a territory of 19,000,000 acres, of which fully 14 per cent. lies over the 1,500 feet limit, and nearly one-half is made up of rough hill-grazings rising in part over that level. This leaves for permanent cultivated pasture for rotation grasses and clovers, and for the surface over which the plough can annually range, not quite 5,000,000 acres. The "cultivated area" can be shown to have lost and gained in the interval if the statistics of the Highland and Agricultural Society in 1854–56 be taken as the starting point.

* Abstract of paper read before the Agricultural Section of the British Association, by Major P. G. Craigie, C.B.

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Adding their estimate of 238,000 acres of arable land on the minor farms, 42,000 in number, to their more detailed analysis of the surface farmed by 43,000 larger occupiers, we find 3,750,000 acres was regarded as "arable." The advent of the Agricultural Returns of 1866 suggest as the feature of the intervening decade a large and rapid shrinkage of the arable acreage. Taking a five-year average up to 1870—only 3,360,000 acres could be so regarded. This figure rose to 3,670,000 acres in 1886–90 and did not fall below 3,500,000 acres till the twentieth century opened. It was 3,460,000 acres in 1901–05 and just under 3,400,000 in 1906–10, and therefore at the date of the new census of production. The changes between 1854–56 and 1866–70 included a diminution of 386,000 acres coincident with the abandonment of a large area of wheat after the abnormally high prices of the Crimean War disappeared. The latter changes, which we can measure more exactly from 1870 to 1910, show that some 200,000 acres of grain were lost, including 74,000 acres of wheat; there were nearly 100,000 acres of turnips and potatoes less, balanced by a growth of nearly 200,000 acres of rotation grasses. The permanent but cultivated grass in the same forty years augmented steadily from a round million to 1,500,000 acres. If crop areas are less the yields are all higher, and the wheat crop of the census year reached forty-one bushels per acre against less than twenty-eight in the fifties, barley thirty-six against thirty-three, and oats thirty-nine against thirty-two, while the potato yield of under four tons reached seven tons in 1908.

Concurrently the cattle maintained in 1854–56 exceeded 1,000,000 head. They rose to 1,157,000 in 1884–86, exceeded 1,200,000 head for 1890 to 1906, stood at 1,174,000 in 1908, and are again at 1,200,000 now. The sheep of 1854–56 only numbered 5,900,000. By 1884–86 they reached 6,848,000, attained a maximum of 7,623,000 in 1891, and with only two drops below the seven-million level were 7,439,000 in 1898, and are still 7,164,000. Herein the Scottish flocks maintained a record over all those of Western Europe, where the loss of sheep was large and significant. The pig stock of Scotland has always found a very small factor, but the level of 1908 at 144,000 was well above the total of the fifties, and is to-day over 170,000.

In the light of the new census the saleable output of Scottish agriculture, however, only reaches £23,150,000 per annum, the crops so far as sold accounting for over a fourth of £6,400,000, the animals and animal products £16,250,000, with £500,000 from "fruit, flowers, and timber," of which the fruit is about two-thirds. What these figures teach is a problem worthy of this new Section's attentive study. If the timber sales, calculated at £181,000 on 868,000 acres, and reaching thus only 4*s*. 2*d*. per acre, be deducted, the remaining agricultural area of under 14,000,000 acres would appear to return less than 31*s*. per acre, while the census report suggests that the rough grazing, of which Scotland shows 9,080,000 acres in its utilised area, can be reckoned to yield only 10*s*. to 12*s*. an acre of saleable output, if indeed this figure is not too high.

These features have to be reckoned with in any survey of the remaining scope for agricultural development, and give point to the directions in which the prospects are most hopeful. The prominent share which the livestock of the farm contributes to the total is enforced, and the student will find in the details now available as to the relative production of differing areas, the prevailing distribution of the land in farm units of various magnitude, and the economic or non-economic expenditure of labour force, topics which bear very closely indeed on the scope for scientific discovery.

FERRO-CONCRETE LINING TO MINE SHAFTS.

What is stated to be an entirely new application of ferro-concrete construction has recently been carried out at the Plenmeller Collieries, Haltwhistle, Northumberland, by Mr. T. Blandford, the engineer to the colliery company, who has adopted the system for lining two new shafts, instead of the usual brick lining, segmental slabs of concrete reinforced with expanded steel being used.

These slabs, which were cast in moulds on the site, were made of a size (3 ft. 1 in. by 1 ft. 6 ins.) convenient for handling, and, after being allowed to season, were lowered into the shaft and fixed in position. The lining of the shaft with such slabs was completed to a depth of 12 fathoms some time ago, and it has since been used under ordinary working conditions.

It is reported as having proved economical in construction and satisfactory in use; so that further lining of a similar nature is now in progress.

The slabs are 5 ins. in thickness, and are reinforced near their concave face with expanded steel, which has a cross-sectional area of ·25 of a square inch per foot of width short-way of mesh. The slabs are tongued and grooved on edges to allow of their fitting and keying into each other, the joints being filled with cement grout to make the segments a monolithic cylinder when placed in position. A hole was left in each slab—about 1 in. in diameter on the concave face, and slightly larger on the convex face—to allow of their being slung and lowered into position, as well as to serve as an inlet for cement grout to be injected into the concrete filling behind them after the slabs had been fixed in position.

The lining of the shafts was completed through water-bearing strata which had been previously treated by the François method of cementation, and the cavity between the reinforced concrete lining and the face of the strata, left in the process of sinking the shafts, was filled with ordinary concrete to a thickness of 9 ins. behind the lining

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during the course of the fixing of the lining; this concrete being finally filled up solid by injection through the lining with cement grout, thus making it watertight.

It is said that the new lining possesses certain advantages over the ordinary brick lining, as being more watertight, and as not requiring any outlay in upkeep once the work is completed.

LAND BANKS.*

The feasibility of the establishment of land banks on a practical and an economic basis has been discussed intermittently for many years. The present depressed state of agriculture and the recent report of the Departmental Committee appointed by the Board of Agriculture and Fisheries to inquire into the position of tenant-farmers on the occasion of any change in the ownership of their holdings, directed attention to the question. Institutions formed for the sole purpose of financially assisting farmers in the purchase of their holdings and developing their industry have been established with marked success in other countries. Some solution of the present difficult question as to the future of agriculture in this country is surely possible. It may be that the prevalent feeling of unrest and uncertainty is accentuated by the campaign against land and its owners. On the one hand we find that owners of large estates are selling—in many cases at considerable loss—their properties, while on the other hand the farmers view with disfavour the idea of being tenants of either the Government or county councils.

It is submitted that a scheme could be devised which would enable farmers to purchase their holdings when offered for sale, without increasing the annual payments which they now make to their landlords in name of rent, and which would at the same return a reasonable rate of interest on the money advanced, provide a sinking fund for the redemption of the loan, and pay the working expenses of the institution.

The system of land banks proposed is self-supporting and free from State control. At first the institution would be confined in its operation to assisting farmers in the purchase of their holdings, with the ultimate intention of extending its scope, as the medium for the buying of seeds and manure, the purchase of pedigree stock, and the selling of farm produce.

The necessary capital to enable the bank to begin operations would be placed by the State at the disposal of the managers of the institution. Interest would be paid to the Government at 3 per cent. on the amount of capital advanced and outstanding from time to time. The Government get money from the Post Office Savings Bank depositors at $2\frac{1}{2}$ per cent. Further sums required would be obtained from the public by the issue of bonds, which bonds would be guaranteed, both as to principal and interest, by the State. There should be no difficulty in getting as much money as is required. At present when a depositor in a savings bank has at his credit the maximum limit, that money is, with his consent, used to purchase Consols, and the depositor thereafter has to take the risks of the market fluctuation of that stock. It is proposed to authorise the savings banks to issue transferable deposit receipts for multiples of £25 on behalf of the land banks, guaranteed by the State, repayable in ten, fifteen, or twenty years at a graduated rate of interest from $2\frac{3}{4}$ to $3\frac{1}{4}$ per cent.

Money would only be advanced to the tenant of a farm who had been on his holding for five years prior to the date of sale. The price would be fixed, failing agreement, by arbitration. The purchase money would be advanced at such a rate of interest as would enable the farmer to continue to pay annually a sum equal to the amount of his rent. The payment so to be received would include the interest paid by the bank for the money advanced, a sum towards a sinking fund, and a percentage to meet expenses and cover losses.

The bank would hold the property in security until the debt was paid. Any profit made would go to form a reserve fund. No dividends would be paid.

* Abstract of paper read before the Economic Science Section of the British Association, by Allan McNeil.

ARTS AND CRAFTS.

The Embroidery Exhibition at the Musée Galliera.—The collection of modern French embroidery of various kinds, which has occupied the Musée Galliera at Paris ever since June, is one of the most interesting summer exhibitions ever held at that gallery. To the English student it is, on account of its extreme comprehensiveness, perhaps of even more interest than to the French worker. English embroidery of late has been running rather on one line, and it would be difficult in this country, at the present moment, to get together a representative show of embroidery embracing so many different types of work as this French exhibition. The large exhibit sent by the Écoles Professionelles de la Ville de Paris was peculiarly interesting in this respect, for it showed what a thoroughly all-round training is being given in these schools. The work sent for exhibition was not above the level to which good schoolwork may reasonably be expected to attain; moreover, some of the naturalistic flower panels were of a type which we should consider old-fashioned and far from desirable. Still, the student who had learnt to do that kind of work, and had been given, in addition, a chance of adapting simple Breton embroidery to the needs of modern Parisian dress, and grasping the use of appliqué in the decoration of portières and the like, as these students seem to do, ought to be in a position to make a far better and more useful trade worker

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than the girl who has only been taught to do one kind of work, however superior artistically that particular kind may be. The elaborate passementerie shown by the Paris schools was very well done indeed. That the French embroidery teaching is not all up to the level of that of the capital is shown by the not altogether successful appliqué exhibited by the Cours Municipal de Broderie Artistique de Lyon.

The church work is, as a whole, the least satisfactory section of the exhibition. The workmanship is hard and mechanical in the extreme, and the one effort in a new direction, a chasuble with a sprigged ground, decorated with orphreys, illustrating the life of St. Francis, is so weirdly up-to-date that one can hardly expect it to influence the trade work.

Amongst the embroidery, which is excellent of its kind without showing any remarkably new characteristics, may be mentioned the wonderful cutwork curtain of M. Edouard Privé, representing a group of mediæval minstrels, the white broderie des Vosges of M. Maurice Weil, and the delicate handkerchiefs of M. Gabriel Prévôt. There are embroidered trimmings of all sorts, some more gorgeous than beautiful, others characterised by a very exquisite taste. Among them the little samplers of simple braiding patterns of M. Paul Mail may be noticed as peculiarly suggestive.

A certain amount of French embroidery in string has been shown from time to time at international exhibitions, but this has hardly prepared us for the large landscape panels—formal gardens and the like of Mme. Ory-Robin and Mdlle. Sabine Desvallières. They are executed on a background of linen, almost entirely in appliqué of coarse, coloured linen damask, outlined with stout string. The description of them is by no means attractive, but the work itself, though very coarse and rough when you look carefully into it, forms very tasteful and wonderfully delicately toned decoration. The large screen of conventional design, carried out entirely in string, is again very pleasing and effective. The square panel of Mme. Laplace, worked in string couched down in filoselles of different colours, is an interesting departure in work of this kind. The other string work is, of course, though very pretty and delicate in tone, distinctly on the cold side, but string oversewn with coloured silks lends itself to a totally different and, in a way, a rather more interesting colour-scheme.

Some of the most interesting pieces of coloured silk embroidery are more or less spoilt by their association with paint. M. René Lalique's fine portière, with its swirling-haired wind amongst the trees, is the most striking thing in the exhibition and a wonderful piece of colour. The salmonish pink of the ground, from which the head only slightly distinguishes itself, and the purply-blue trees form a most attractive bit of colouring; but the needle has been helped out of its difficulties by the brush, and the piece is far less satisfying than it would have been had it been entirely executed in needlework. Another rather amusing departure is squares of silk treated apparently in some way analogous to marbled end-papers, and then slightly embroidered in places. The effect is very fresh, but one wonders rather how it has been attained, and whether the real charm of the colour will remain, or whether it is merely temporary. In any case, though the embroidery in a way helps the effect, it takes quite a subsidiary place, and one feels that this kind of work is not really suitable to an embroidery exhibition.

Apart from these more ambitious exhibits, there is a mass of good, competent work of all kinds, ranging from the coarsest appliqué to the finest white work. The design, too, is as varied as the execution—naturalistic, conventional, geometric, grave or gay, according to the fancy of the designer and the needs of the work. It is really in this diversity, even more than in the real merit of the best individual works, that the strength of the exhibition lies.

French and English Furniture.—The two kinds of work which probably occur to most people when they think of French artistic manufactures are jewellery and furniture, and far apart as these two crafts are, there is one characteristic in which the French work in both departments is, for the most part, distinguished from the English—its sense of style. It is true that this sense manifests itself in very different ways, but it is there none the less. With regard to furniture, the French have so firm a hold on the styles of the later Louis and of the Empire that they seem unable to depart from them. It is quite astonishing to the Englishman, used to seeing a good deal of fairly simple furniture of a modern type, to note in the ordinary Paris shops how extraordinarily little there is which can be said to be on anything but strictly traditional lines. It seems almost as though invention had stopped a hundred years or so ago, and people had done nothing but copy ever since. That is, of course, an overstatement of the case, but the fact remains that the type has persisted, without that amount of modification which natural growth would suggest. This is, in a way, a pity. Any sort of stopping short is a thing to be regretted; but still it must be remembered that this does not imply in France just what it would in England. When English people, with much care and forethought, furnish their rooms consistently in the style of a by-gone time, the result may be quite charming to the eye, but it suggests at least a trifle of affectation: we are inclined to think that the room is not the spontaneous expression of the owner's own taste. The modern Chippendale is not what the workman naturally produces, it is a style he has more or less laboriously learnt. On the other side of the Channel it is rather different; people use, say, Empire furniture more or less naturally, not because it is the fashion to return to a past style, but because that style is still

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alive for them; they take it as a matter of course, and the maker for his part has grown up making it. The result is that French furniture, whether we like it or no, and however much we may deplore its want of originality, has a certain quality—that of style—a style which really belongs to it and has not been assumed, which saves it from ever falling to the lowest depths.

French Jewellery.—Matters are rather different when we come to jewellery. In this craft the French artist craftsman is as unfettered as the Englishman, and he often does work which at first sight has nothing to do with traditional styles, but his output is characterised by a sense of style none the less, and by a distinction which English artistic jewellery often lacks. The British craft jeweller is at present a comparatively new departure, and far from having the traditions of his trade at his fingers' ends, he has often had to learn them late in life—has sometimes deliberately turned his back on them. The result is that, though he has achieved a very considerable measure of success he has done it for the most part by limiting himself to simple workmanship. It remains to be seen whether he will content himself permanently with this or will go further. The Frenchman, on the other hand, betrays his accomplishment at every turn. He revels in his material and loves to show his mastery over it. When he errs he does so not as a rule on the side of simplicity but on that of the over-elaboration which comes of the desire to produce a *tour-de-force.* Surely the ideal jewellery would be characterised by a combination of these two qualities, the English simplicity and the French mastery of the material. The *tour-de-force* is often enough ugly, but this is not because it is accomplished, but because it is lacking in restraint. That is a point which should be realised rather more than it is.

With regard to the French work of the moment, it is interesting to note that a fair amount of work in the Egyptian style seems still to be done, and that a great deal of attention is being paid to the production of signet and other rings with large stones. The setting and mounting of such stones is providing scope for a good deal of ingenuity which is by no means misplaced. This appears to be a field in which our own craft workers have so far done very little and which might provide an opening.

OBITUARY.

SIR HORATIO DAVID DAVIES, K.C.M.G.—Sir Horatio Davies died at his residence, Watcombe Hall, Torquay, on the 18th inst., at the age of seventy. After being educated at Dulwich College, he entered the well-known catering business of Pimm's in the Poultry. In 1885 he became a member of the Court of Common Council for Cheap Ward; in 1887–8 he served in the office of Sheriff of London and Middlesex, and in 1889 he was elected to the Court of Aldermen for Bishopsgate Ward. From 1895 to 1906 he sat in the House of Commons as representative of Chatham. But he is, perhaps, best remembered as Lord Mayor of London, a post which he occupied in 1897–8, when he is said to have entertained more lavishly than any previous occupant of the Mansion House. At the close of his mayoralty he received the honour of K.C.M.G.

In addition to Pimm's Restaurant, Sir Horatio Davies was interested in the "Ship and Turtle" in Leadenhall Street. He was also the owner of hotel property at Eastbourne and in the Isle of Wight, and was engaged in building operations on a large estate at Nottingham and elsewhere. He had travelled much, and had only a few weeks ago returned from a journey to South Africa. He was a Justice of the Peace and Deputy Lieutenant for Kent, where he owned till recently the estate of Wateringbury Place, near Maidstone; a past Master of the Spectacle Makers' and Loriners' Companies, an Officer of the Legion of Honour, and a leading Freemason.

For many years he was an officer in the 3rd Middlesex Artillery Volunteers, and retired with the honorary rank of Lieutenant-Colonel and the Volunteer Decoration.

Sir Horatio Davies was the possessor of a valuable collection of pictures by old and modern masters, and of old silver and other curiosities. He became a member of the Royal Society of Arts in 1888.

GENERAL NOTES.

VICTORIA AND ALBERT MUSEUM.—The Department of Engraving, Illustration and Design, of the Victoria and Albert Museum, has recently acquired, by purchase, a large number of original studies by the late Frederick Shields, for his well-known illustrations to Bunyan's "Pilgrim's Progress." They have been mounted with the wood-engravings to which each group relates; and a selection of about ninety is now exhibited in Room 70. This series, with a set of drawings for Defoe's "Plague of London," some of which are now in the Manchester Art Gallery, constitute Shields' chief contribution to the great period of English book illustration, the "sixties"; and, when published, they received high praise from Rossetti and other artists, as well as from John Ruskin. The same room also contains two original pen-drawings by the late E. A. Abbey, R.A., for "She Stoops to Conquer" (1885), and "The Quiet Life" (1889), given to the museum by Mrs. Abbey, in memory of the artist, as well as another study purchased for the collection, which is thus enriched with a representation of the work of one of the most distinguished of the pioneers of modern methods of illustration. Mr. Stanhope Forbes, R.A., has given eleven etchings by the late Mrs. Stanhope

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Forbes, whose graceful and accomplished work in this medium, belonging to the earlier period of her artistic career, is by no means as widely known as it deserves. Among other recent accessions, wholly or in part now exhibited, are four drawings by the late L. R. Garrido (1868–1909), given by Mrs. Garrido; a collection of twenty-one working proofs, etc., of etchings by the late David Law (1831–1902) given by Miss Law; two etchings by Mr. D. Y. Cameron, A.R.A., "Rameses II." and "The Lion and the Unicorn," given anonymously; and four studies by James Ward, R.A., given by Mr. A. E. Anderson; four studies for "The Harvest Moon," and other pictures, by G. H. Mason, A.R.A., have been purchased, and are also shown.

Basket-making in Jamaica.—Although baskets made in Jamaica are on sale and in general use throughout the island, their manufacture is confined chiefly to the parish of St. Elizabeth in the south-western part of Jamaica. At Lacovia, in that parish, the principal manufacturer makes such a variety of baskets that it takes sixty-seven samples to show all the styles. The material mostly used is the leaf of the palmetto, which is locally known as the "bull thatch palm." This tree thrives well in the morasses. The leaves of the palm are cut off and placed in the sun for three days; then split into the desired widths and exposed to the sun for six days more, after which the strips are bleached in the dew for a night, and again exposed to the sun for a day, when the material is ready for use. The baskets are all made by hand. A favourite style is called "bankra," a covered basket made in many sizes. Bamboo is used for making strong market baskets. Although an immense number of baskets are manufactured and sold in Jamaica, the market being especially brisk during the tourist season, the quantity exported is insignificant. Considering the attractiveness and cheapness of many of these baskets, it seems that it would be possible to build up a considerable export trade for them.

Algerian Vegetable Fibre.—Vegetable fibre, or *crin végétal*, is made from the leaves of a dwarf palm which clings to the soil tenaciously. Its presence was a serious obstacle to the pioneers of Algerian colonisation, and it had to be fought foot by foot. It was not then known that the plant would become a source of wealth to the colony, and that it would be more and more sought after as a commercial product. The palm grows abundantly in Algeria in sandy soil, among rocky mountains, as well as in rich, deep soil. Heat, cold, rain and drought do not harm it. After several attempts had been made to utilise the palm, satisfactory results were obtained in 1847. The leaves were separated by a comb into long and flexible filaments, which were twisted into rope shape. The palm leaves are plucked by the Arabs only when they have nothing else to do, the work being poorly paid. In years of drought it is their only resource. Treated on the spot, simply and economicaly, and slightly dried, the leaves are sold by local manufacturers to export firms on the sea coast, where, after a fews days' exposure to the sun, they are made up into bales. *Crin végétal* serves well for stuffing furniture and mattresses, and it can be used for cleaning and polishing floors, wood, and brass work. Its use for domestic and other purposes is causing increased sale, replacing many other more expensive articles. The most important customers for Algerian *crin végétal* are the United States, Italy, Germany, Austria, Belgium, and France.

Exposure Tests of Light Aluminium Alloys.—In a paper read before the Mechanical Science Section of the British Association, Professor Ernest Wilson remarks that during the past eleven years reports on this subject have been presented to the Association at fairly regular intervals. The tests show that alloying commercial aluminium with copper, unaccompanied by iron, nickel, or manganese, is not satisfactory. A 2·6 per cent. copper alloy has completely deteriorated in ten years, and increased its electrical resistance 25 per cent. "Duralumin" is a copper manganese alloy of aluminium, with the addition of about 0·5 per cent. magnesium. During the last year a specimen has increased its electrical resistance 5·15 per cent. It would be interesting to know if this is due to the comparatively large percentage of copper (3·5 to 5·5) which this alloy is stated to contain, or if the percentage of manganese (0·5 to 0·8) is too low. This alloy has attracted attention in that a breaking-load as high as 90,000 pounds can be obtained, if desired, according to treatment. Its specific electrical resistance at 15° C. is about twice that of commercial aluminium. A specimen of high-conductivity copper wire has increased its electrical resistance 1·2 per cent. in one year.

Monograph on Italian Irrigation.—The executive committee of the International Exhibition of Irrigation and Rice Culture, which will be held this autumn at Vercelli, have offered prizes for a monograph on irrigation in Italy at the present time. The first, of 1,000 lire (£40) and a gold medal, and the second, of 500 lire (£20), will be awarded to the writers of the two best. They must contain descriptions of all the principal works of irrigation in the country (Italy), and the results obtained since they have been opened; tables showing the lengths and principal dimensions of the chief canals, where situated, quantity of water supplied, the areas irrigated, results obtained, etc.; description of the various systems employed for the measurement and distribution of water in the various regions in Italy; consumption of water for the different kinds of crop; legislation in Italy for the use and distribution of water for agricultural purposes; as well as other data relating to irrigation in that country.

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Journal of the Royal Society of Arts.

No. 3,124. VOL. LX.

FRIDAY, OCTOBER 4, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

CANTOR LECTURES.

The Cantor Lectures on "The Materials and Methods of Decorative Painting," by Mr. Noel Heaton, B.Sc., F.C.S., have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.

A full list of the Cantor Lectures, which have been published separately, and are still on sale, can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

HEAVY OIL ENGINES.

By CAPT. H. RIALL SANKEY, R.E. (Retired), M.Inst.C.E.

Lecture I.—Delivered April 29th, 1912.

INTRODUCTION.

The name "oil engine" includes to-day many types and varieties. About twenty years ago there was only one type on the market, represented by such engines as the Priestman and the Hornsby-Ackroyd. These engines used paraffin or ordinary lamp oil, having a specific gravity of about 0·82. This oil requires heat for vaporisation in order to produce an explosive mixture, and engines using it are now included in the category of "heavy oil" engines.

Later, in the year 1890, Daimler brought out his petrol engine, in which a volatile oil of 0·680 sp. gr. was used. With such oils vaporisation takes place at ordinary temperatures and air is readily "carburetted," thus forming an explosive mixture. Such engines are called "light oil" engines.

Comparatively recently the Diesel oil engine was placed on the market, and in this type of engine the oil is not vaporised to form an explosive mixture, but is mechanically pulverised, and burns in the engine cylinder, that is, it does not explode in the ordinary sense of the word. The Diesel engine is also a "heavy oil" engine.

There are numerous varieties of each type of engine, sometimes called after the kind of oil they use, such as benzine engines, petrol engines, paraffin engines, and crude oil engines. Incidentally, the latter is a misnomer, because the crude oil is that which comes out of the ground, and contains all the other oils. These engines can therefore be distinguished as follows:—

Light Oil Engines.—An explosive mixture is formed by carburation at atmospheric temperatures. The oils used have a specific gravity as low as 0·68, but usually about 0·72. They are called "Petrol engines."

Heavy Oil Engines.—An explosive mixture is formed by vaporisation at comparatively high temperature—or a combustible mixture as formed by mechanical pulverisation—specific gravity of oils, 0·8 to 1·0.

These lectures will be confined to heavy oil engines, and will deal principally with the Diesel engine, as being the most important.

Heavy oil engines can also be classed as:—

(*a*) Explosion engines;

(*b*) Combustion engines.

Three types of the former are illustrated in Figs. 1, 2 and 3.* Fig. 1 represents the type of the original Priestman engine, in which the oil is vaporised in a hot bulb. Before starting, this bulb has to be heated by means of a lamp, which takes about a quarter of an hour. In Fig. 2 the oil is vaporised by falling on to

* These figures, as well as Figures 13, 16, 21 and 22, are reproduced by permission of the American Society of Mechanical Engineers, from a paper by H. R. Setz on "Oil Engines."

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baffle plates, which are heated by the exhaust, and forms an explosive mixture with the air drawn in on the suction stroke. Such engines are ignited by means of an electric spark, and have to be started by means of petrol, and the heavy oil can be introduced so soon as the baffle plates have reached a sufficient temperature. In Fig. 3 there is a stream of air compressed from 8 lbs. to 25 lbs. per square inch, which pulverises the oil, after which it is immediately vaporised in the chamber heated by the exhaust gases.

The second class, namely, combustion engines, consists of the Diesel engine and of the so-called semi-Diesel engine. In the former, pure air is compressed in the cylinder to a pressure (450 lbs. to 500 lbs. per square inch) sufficient to cause ignition, and the oil is pulverised and introduced into the cylinder at the top of stroke by means of air at a still higher pressure (700 lbs. to 900 lbs. per square inch).

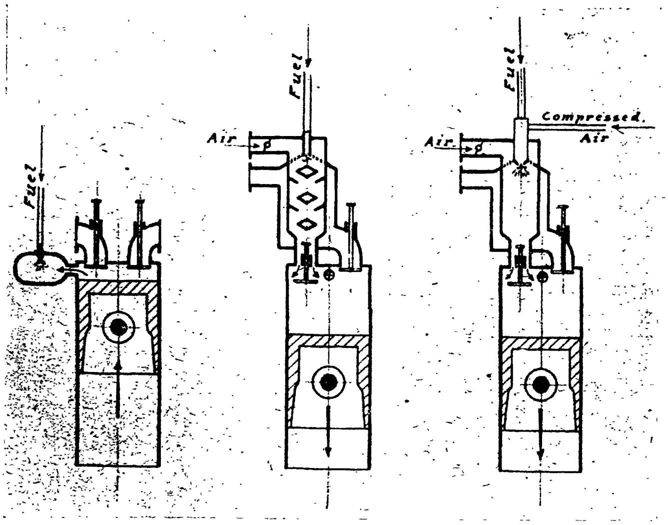

FIG. 1. FIG. 2. FIG. 3.

In the semi-Diesel engine, pure air is also compressed in the cylinder, but only to about 200 or 250 lbs. per square inch, the ignition temperature being reached by means of a hot bulb into which the oil is injected by a pump at the top of the stroke.

Judged by the sizes, and the total horse-power at work or under construction, the Diesel engine is to-day the most important type, and will, therefore, be first considered.

Short History of Diesel Engine.

Not many years ago the Diesel engine was known as a promising oil engine to few engineers, but its development has been so rapid—not to say extraordinary—that assuredly everyone, not only engineers, has some acquaintance with it. The reason is obvious, namely, that it can utilise and convert into power types of oil hitherto unusable for power, and it works reliably and with the greatest economy of fuel. This result has, however, only been obtained by long, costly, and patient research and trial.

A short historical account of the developments will, therefore, be of interest, and the following has kindly been supplied by the Maschinenfabrik Augsburg-Nürnberg Co., who were the pioneers in the experimental work.

Historical Sketch of the Diesel Oil Engine.

Dr. Diesel applied for his patents in Germany and other countries in 1892.

The Augsburg works of the Maschinenfabrik Augsburg-Nürnberg Co., in conjunction with Messrs. Krupp, of Essen, entered into an agreement with Dr. Diesel to make all tests and experiments for the carrying out of the patents and to install at Augsburg a special laboratory, equipped with all the necessary technical and scientific means for this purpose. The two German patents were acquired at the same time (1893) by the two above-mentioned firms.

Dr. Diesel was at the head of the laboratory, but all the costs were borne by the Maschinen-fabrik Augsburg-Nürnberg Co., and Messrs. Krupp. The engine illustrated in Fig. 4 was the first experimental engine.

It was soon found that the chief idea of Dr. Diesel—viz., to obtain the highest temperature

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of the cycle before the actual combustion, and to get an isothermic combustion—could not be realised, and that water-jacketting of the cylinder, which Dr. Diesel thought he could avoid, was necessary.

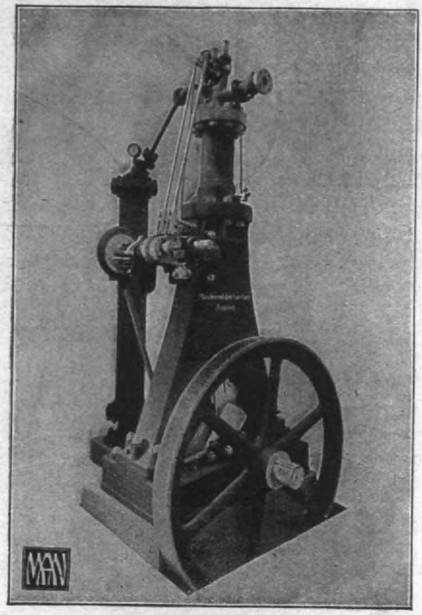

FIG. 4.

Notwithstanding these initial disappointments, the owner of the Augsburg works—Herr von Buz (now Geheimer Kommerzienrat Heinrich von Buz)—and the Augsburg engineers, especially Herr Lauster, persevered and succeeded in building, in 1897, the first engine of 20 B.H.P. (Fig. 5), which was tested by many scientific authorities, and placed the Diesel engine at once, so far as thermal efficiency was concerned, at the head of all prime movers.

This was the first task, the carrying out of which was only rendered possible by sacrifices on the part of the Augsburg works of the Maschinenfabrik Augsburg-Nürnberg Co. and Messrs. Krupp.

The second task, viz., to build a commercially useful engine, was then undertaken by the Maschinenfabrik Augsburg-Nürnberg Co. and their several licensees, as well as by firms in other countries, as, *e.g.*, Mirrlees & Watson, who had bought the patents of their respective countries from Dr. Diesel, after the first scientifically successful engine had been completed at Augsburg.

After the first experiments, however, firms like Sulzer Bros., Carel Frères, Gasmotorenfabrik Deutz, etc., gave the whole thing up, although they had partly received drawings and technical hints from the Augsburg works of the Maschinenfabrik Augsburg-Nürnberg Co.

Only the Augsburg works of the Maschinenfabrik Augsburg-Nürnberg Co. succeeded, and sold and delivered in the beginning of 1898 an engine of 60 B.H.P. (Fig. 6) to the match factory "Union," at Kempten, which is still in satisfactory working order.

The commercial success attained by the Augsburg works of the Maschinenfabrik Augsburg-Nürnberg Co., then induced other firms, such as Sulzer Bros., Carel Frères, Mirrlees, Bickerton & Day, and others, to begin again, in 1903–04 or later, the manufacture of Diesel engines.

The history of the English Diesel business is briefly as follows.

In March, 1897, Dr. Diesel sold his patents to Mirrlees, Watson & Yaryan Co., Ltd., and they built an experimental engine. Meanwhile, a special company, "Allgemeine Gesellschaft für Dieselmotoren A.G., Augsburg," had acquired, in September 1898, all the patent rights of Dr. Diesel. This company bought the patents

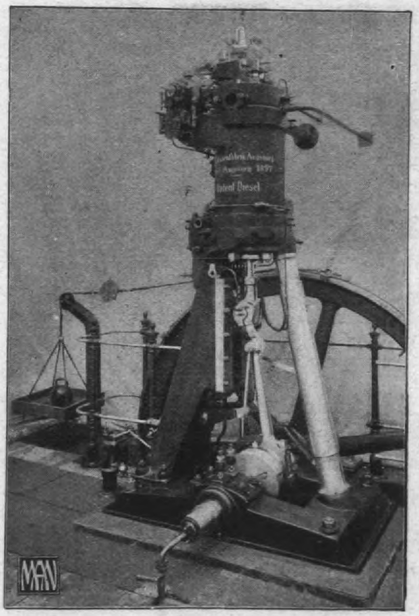

FIG. 5.

back from Mirrlees, Watson & Co., in September 1899, and entered into a new agreement with this firm in November 1899.

In November 1900, the "Allgemeine" sold the patent rights for England and the Colonies, and

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some other countries, to the Diesel Engine Co., Limited.

The Diesel Engine Co. then became, and until recently was, exclusively a selling company, and during the first years only sold Diesel engines of the Augsburg works of the Maschinenfabrik Augsburg-Nürnberg Co.

The two chief English patents covering the Diesel cycle, and belonging to the Diesel Engine Co., expired in 1906 and 1909, so that the manufacture of Diesel engines can now be attempted by anybody in this country.

The Maschinenfabrik Augsburg-Nürnberg Co. were, therefore, the pioneers, and have since retained their place at the head of all manufacturers.

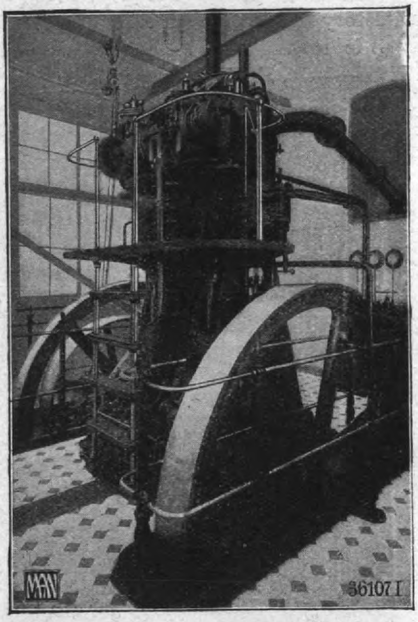

Fig. 6.

A great number of Diesel engines, of the vertical single-acting, four-cycle type, were built by the Maschinenfabrik Augsburg-Nürnberg Co. in the following years. When the first really large engines of 600 and 800 B.H.P. were built in 1906–07, it became apparent that they could be built better, simpler and more accessible on the lines of the then well-proved horizontal double-acting Nuremberg gas engines. An experimental tandem engine of 600 B.H.P. was built at Augsburg, which proved quite satisfactory, and was soon followed by an order for an engine of 1,600 to 2,000 B.H.P. from the Municipal Electricity Works of Halle (Germany). At present eighteen such horizontal double-acting engines, ranging from 600 to 2,000 B.H.P., are under construction. Fig. 7 illustrates such horizontal engines.

Somewhat later, the Maschinenfabrik Augsburg-Nürnberg Co., after exhaustive experiments, also placed on the market horizontal single-acting Diesel engines, of the four-cycle and two-cycle type for medium powers.

Since 1903 many firms have undertaken the manufacture of Diesel engines, and to-day the horse-power at work cannot be far short of one million.

The first reversing marine engine was built by Messrs. Sulzer in 1905 for a boat on the Lake of Geneva, and since then the marine Diesel engine has made rapid strides. Engines of 4,000 h.p. have been built for this purpose, and much larger are in contemplation.

Until recently, the development of the Diesel engine has been slow in this country, due, to a certain extent, to a want of enterprise and to distaste for anything new, especially if it has not originated in this country. The slow development, however, is in large measure due to cheap coal, although this country has an enormous field throughout the Empire, in many parts of which oil, when used in the Diesel engine, is a cheaper fuel than coal.

The recent papers by Mr. Milton, read before the Institution of Naval Architects, and by Dr. Diesel, read before the Institution of Mechanical Engineers, have, however, awakened interest, especially for marine work. A full historical account will be found in Dr. Diesel's paper; the above is only a sketch intended to show the rapid development of the engine.

Thermodynamical Considerations.

All prime movers by means of which useful work can be produced by utilising a "heat fall," can be divided into two main groups—namely, external-combustion engines and internal-combustion engines. The heavy oil engines belong to the latter.

In the case of water wheels and water turbines, a "water-fall" is utilised, and the maximum energy available per pound of water is proportional to the height through which the water falls. Practically, however, only a fraction, varying from, say, 50 to 80 per cent. of this maximum energy is converted into useful work.

In the case of a heat engine the "heat fall" is measured by the number of thermal units theoretically rendered available for utilisation as work by the change in condition produced in

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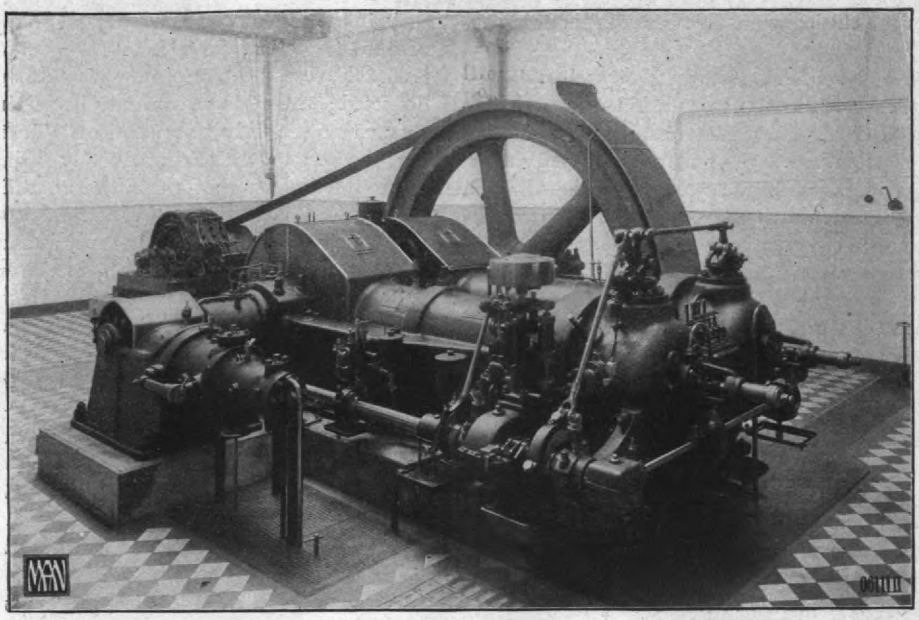

Fig. 7.

the working fluid by the agency of the cycle operations followed by the particular type of heat engine adopted. In passing through the engine the temperature of the fluid is reduced, but in no actual engine is this fall of temperature, by itself, a measure of the heat fall, because it also depends, and in large measure, on the manner in which the heat is introduced into the working fluid, and on the manner in which it is abstracted therefrom.

The simplest way of exhibiting the above is by means of a heat chart, the ordinates of which represent absolute temperature to an equally divided scale, the base line being at the temperature of absolute zero. Let the point P (Fig. 8) represent the location on the chart of the fluid before any heat is introduced, and let P_1 be its position after heat has been introduced. Further, let the chart be so constructed that the area $P\ P_1\ P_2\ P_3$ represents the number of heat units introduced in some manner or other, and let this amount be H. By virtue of the mechanism of the engine, the heat energy does work which is suitably transmitted to, say, a revolving shaft. Let P_2 represent the condition of the fluid at the beginning of the period of abstraction of heat, and let P_3 represent its condition at the end of this period, then the area $P\ P_3\ P_2\ P_1$ represents the heat abstracted, and clearly the difference between the heat introduced and that abstracted—namely, the heat introduced by the area $P\ P_1\ P_2\ P_3$ is the heat converted into work. Let this amount be represented by W, then the ratio $\frac{W}{H}$ is known as the thermal efficiency of the operation. The endeavour is to make this ratio as large as possible, but, unfortunately, for various reasons, it cannot be made very large.

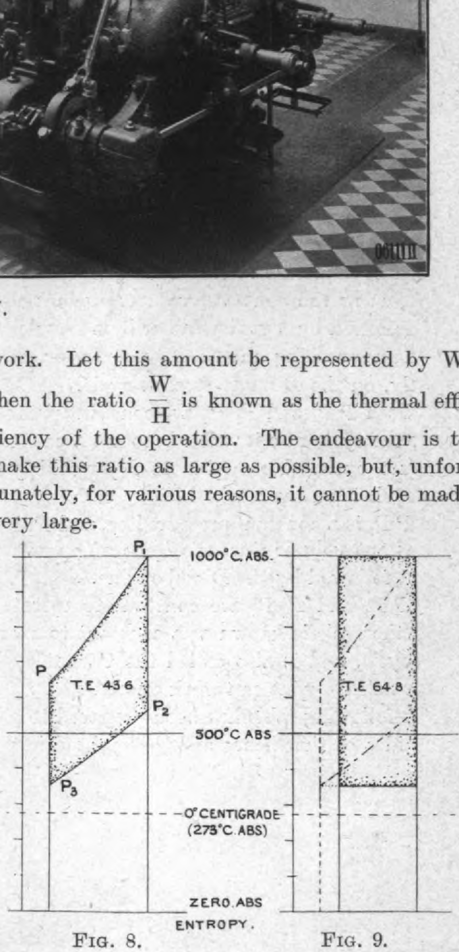

Fig. 8. Fig. 9.

In Fig. 9 a special case is illustrated, in which both $P\ P_1$ and $P_2\ P_3$ are horizontal—that is to say, the heat is introduced at constant temperature, T_1, and is also abstracted at constant temperature, T_3. This figure has been so drawn that the amount of heat introduced, H, is the same as in Fig. 8, and it is clear that the ratio $\frac{W_1}{H}$ is greater in this case than in the former, and it can in fact be proved to be the greatest

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thermal efficiency possible between the temperatures T_1 and T_3.

It can further be shown that each point on this chart defines the condition of the fluid—that is to say, curved lines can be drawn on the chart from which the pressure and the volume at any point can be ascertained. Thus, if through the admission of heat from P to P_1 the volume remains constant, the line $P P_1$ forms part of a constant volume line; or, again, if the pressure were to remain constant, it would form part of a constant pressure line. These same remarks apply to line $P_2 P_3$ followed during the abstraction of heat usually known as the exhaust period.

If both $P P_1$ and $P_2 P_3$ are constant volume lines, the cycle of operation is known as a constant volume cycle, and it will be further observed that since $P P_2$ and $P_1 P_2$ are vertical lines, obviously, from the construction of the chart there will be no change of heat during those parts of the cycle. These lines are known as adiabatics. The cycle just described is known as the constant volume cycle, and is that followed by a gas engine or by an explosion oil engine working on the Otto cycle, or, more strictly, on the Beau-de-Rochas cycle.

If both $P P_1$ and $P_2 P_3$ are constant pressure lines, the cycle of operation becomes a constant pressure cycle. No engine to-day working on this cycle is on the market.

If $P P_1$ is a constant pressure line, and $P_2 P_3$ is a constant volume line, the cycle of operations is that followed by the Diesel engine.

If $P P_1$ and $P_2 P_3$ are constant temperature lines, the cycle is known as a constant temperature cycle, and is also called the Carnot cycle. No practical engine can work on this cycle.

The following table has been prepared to give some idea of the theoretical thermal efficiencies obtainable under various conditions—

As in the case of water engines, only a fraction of the theoretical possibilities are practically realisable, because various losses have to be deducted; these losses can only be minimised, they cannot entirely be got rid of. That is to say, the amount of heat practically utilised as work is less than that theoretically utilisable, and the ratio of the lesser amount to that supplied is called the actual thermal efficiency of the engine.

The ratio between the actual thermal efficiency of an engine and the theoretical thermal efficiency of its cycle is known as the "efficiency ratio," and substantially may be taken as follows, for certain typical heat engines:—Non-condensing steam engines using saturated steam, 60 to 80 per cent.; condensing steam engine, using superheated steam, 50 to 70 per cent.; gas engines, 80 to 88 per cent.; oil engines (explosion type) and Diesel engines, about 75 per cent.

The actual thermal efficiencies of various engines referred to in Table I. have been deduced from the above, and in the figures given under that heading allowance has also been made in the case of steam engines for boiler losses, etc., and for producer losses in the case of gas engines.

It has already been stated that between given values of the highest and lowest temperatures occurring in the cycle, the Carnot cycle has the greatest possible thermal efficiency, and, for the sake of comparison, this thermal efficiency has been added to the table for each item.

As a further comparison, heat chart diagrams of some of the engines entered in the table are given in Fig. 10 on the assumption that the amount of heat introduced is the same in all cases, and this being so, the areas enclosed in thick lines, representing the possible conversion into work, are in proportion to the theoretical

TABLE I.

Description of Plant.	Abs. temperatures. Theoretical °C.		Thermal Efficiency.			
	Highest.	Lowest.	Theoretical Cycle.	Carnot Cycle.	Actual Plant from per B.H.P.	Actual Plant to per B.H.P.
Non-Condensing Steam Plant . . .	458	373	17·8	18·2	4	8
Condensing Steam Plant Superheated	561	310	31·0	45·0	10	15
Gas Engine and Producer	2100	370	47·0	82·5	16	24
Oil Engine	2000	370	40·0	82·0	16	19
Diesel Engine	2000	370	56·0	82·0	26	32

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thermal efficiencies. The various losses are deducted, and the remainder indicated by the areas shaded by dots are proportional to the actual thermal efficiencies.

The great thermal efficiency of the Carnot cycle has been a considerable temptation to inventors forgetful of the fact that, apart from other difficulties, such an engine would have a

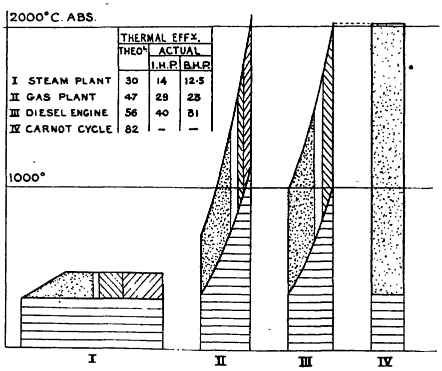

FIG. 10.

very small mean pressure in the cylinder, and therefore would require enormous pistons and cylinders.

However, it was from an attempt of this nature on the part of Dr. Diesel that he gradually evolved the oil engine which bears his name. In 1892 he published a book which was translated into English by Bryan Donkin, jun., entitled, "Theory and Construction of a Rational Heat Motor," in which he argues that if combustion is carried on in a cylinder at constant temperature, theoretically a slightly higher efficiency than that of the Carnot cycle can be obtained, because a less weight of the fluid has to be compressed than has to be expanded, owing to the addition of fuel being made after compression. He appears, however, to have forgotten that the abstraction of heat in the case he considered could not be effected at constant temperature, or at any rate he assumed that it could so be extracted. The cycle he then proposed was, therefore, unrealisable; moreover, it is not at present practically possible so to regulate the oil admission as to obtain a constant temperature, but rather an approximately constant pressure is obtained. Hence, as a practical matter, as already stated, the Diesel oil engine works on a constant-pressure volume cycle, the thermal efficiency of which is given in Fig. 10, whereas, under the same range of temperatures Herr Diesel expected to get a thermal efficiency of 0·855, corresponding to a coal consumption of 0·25 lb. per h.p., for it should be mentioned that the first trials were made with pulverised coal and not with oil, and designs for an engine working in this manner are given in the book referred to.

In the ordinary gas engine or explosion oil engine the heat is introduced to the working fluid theoretically at constant volume, because, the mixture being exploded, the combustion is complete before the piston moves from the dead point. Practically, however, a considerable portion is added at increasing volume, because the explosion is not instantaneous, and this is a cause of loss. In the Diesel engine the oil is introduced comparatively gradually, and at such a rate that the pressure remains nearly constant: the indicator diagram will, therefore, theoretically have a flat top; practically, only an approximation to a flat top is obtained, as shown in Fig. 11, which gives both a theoretical and a practical diagram. On this figure are also shown theoretical and practical indicator diagrams of an ordinary gas engine for the sake of comparison.

These indicator diagrams illustrate the fundamental difference between the Diesel and the Otto engines. In the Diesel engine the continued combustion of the oil is achieved, as already mentioned, by pulverising it and injecting it in this state into the cylinder by means of an air blast, and, owing to previous compression up to about thirty-two atmospheres (500 lbs. per square inch), the air in the cylinder is at a sufficiently high temperature to ignite the oil.

Attention is called to the difference in the compression reached, as shown in these two

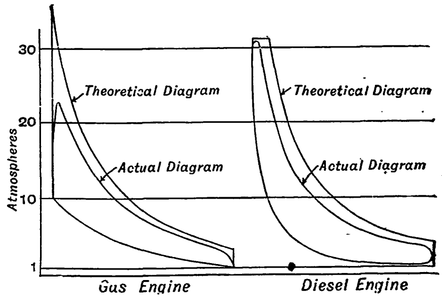

FIG. 11.

diagrams; in the case of the Otto engine, the explosive charge is compressed about 130 lbs. per square inch gauge; a greater pressure is not practically permissible for fear of pre-ignition. In fact, this is about the highest compression used in gas engines working with producer gas; with town gas it is less, and with ordinary oil or petrol engines the pressure has to be still

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further reduced—namely, to about 80 lbs. per square inch, and it is this low compression which prevents this latter type of engine having a high thermal efficiency.

In the Diesel engine, however, the combustible matter is added at the top of the stroke on the turn of the piston; only air is compressed, and therefore pre-ignition, in the ordinary sense, is not to be feared; consequently, much higher compressions are possible, which is the real cause of the great thermal efficiency of the Diesel engine. This high compression raises the temperature of the air to about 700° C., so that the temperature in the cylinder at the moment the oil is injected is sufficient to cause its ignition, thus no special means of ignition, such as the electric spark or the hot tube required by the ordinary gas engine, are needed.

In the semi-Diesel engine, as already stated, the compression of pure air is considerably less, and the pulverised fuel is injected into a hot

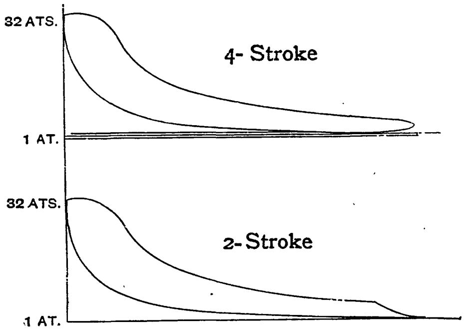

FIG. 12.

bulb, which causes it to ignite. The heat is introduced into the working substance partially at constant volume and partially at constant pressure.

This immunity from pre-ignition of the Diesel and semi-Diesel engines may be regarded as a great advantage these types have over the ordinary gas or oil engine, because it may be safely said that a large proportion of the troubles which have arisen in connection with large gas engines are due to pre-ignition.

The cycle followed by the Diesel engine can now be stated completely, and is illustrated diagrammatically in Figs. 11 and 13. A charge of pure air is sucked into the cylinder through the air valve, and on the return stroke this air is compressed to a pressure of from 450 lbs. to 500 lbs. per square inch, so that the ratio of compression needed is about thirteen to one (as against six to one for the ordinary gas engine), and the clearance in the cylinder is arranged accordingly. At from 1° to 2° before the end of the stroke the fuel valve opens and the charge of oil is pulverised by means of an air blast and a special device to be described in detail later, and is injected into the cylinder. The requisite amount of oil, determined by the action of the governor, is forced into a space above the fuel valve by means of a fuel pump. The pressure of the air blast varies from 750 lbs. to 900 lbs. per square inch, according to the proportion of the full load the engine is working at, and an air-compressor has to be provided for supplying this high-pressure air.

After combustion, expansion of the products of combustion takes place, until the exhaust valve opens, which occurs at about 0·9 of the stroke, and then the pressure in the cylinder suddenly drops to atmosphere. Finally, the piston, on its return stroke, sweeps out the remaining products of combustion, and the cycle is complete. It will be seen that four strokes, namely two up and two down (in a vertical engine), are needed for one complete cycle, and the engine described therefore works on a four-stroke cycle, corresponding in this respect to the Otto or Beau de Rochas cycle of a gas engine.

Up to the present the greater number of Diesel engines have been designed on the four-stroke cycle; arrangements can, however, be made to introduce a blast of air into the cylinder at the moment the exhaust valve opens, and thus, not only will the products of combustion be swept out, but also the cylinder will be filled with pure air. The cylinder is then in the same condition as on the second up-stroke of the four-cycle type—that is to say, pure air is compressed, and hence fuel can be injected at the end of this stroke. A combustion stroke will therefore take place at each down stroke, and the engine then works on a two-stroke cycle. In this way double the power can be obtained from a given cylinder. This type of Diesel engine is now being rapidly developed, and eventually will probably be the only type used for large marine engines.

Gas engines also work on the two-stroke, or Clarke cycle, the products of combustion being scavenged just before the explosive mixture is introduced into the cylinder. In this case the difficulty arises that if the scavenge is too powerful, unburned gas will be blown into the exhaust and lost, because it has to be admitted into the cylinder immediately after the scavenging air and before the exhaust ports are closed (except in the case of the Oechelhauser engine).

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If, however, the scavenge is reduced, a portion of the exhaust will be left in the cylinder, thus reducing the weight of explosive charge. These difficulties do not occur with the Diesel engine, because the fuel is not admitted until later, and within reason any amount of air can be blown through the cylinder to clear out completely the products of combustion. Hence the Diesel engine is essentially adapted for a two-stroke engine.

The indicator diagram of the two-stroke engine is somewhat different from that of the four-stroke, and to illustrate this difference average indicator diagrams of a two-stroke and of a four-stroke engine are given in Fig. 12.

Dugald Clerk, in 1887, built an engine using coal gas which followed the Diesel cycle, and which he called a "flame" engine. The air was alone compressed in the cylinder, the gas being compressed separately by a side pump forced into the engine cylinder through a series of gas jets, and ignited exactly as it entered. This engine worked very well, but the mean pressures obtained were too low, because the compression pressure was too low; namely, only 90 lbs. per square inch.*

ESSENTIAL ELEMENTS OF A DIESEL ENGINE.

It will thus be seen that the Diesel engine can work either as a four-stroke or as a two-stroke engine. In the four-stroke engine the following are the essential elements, illustrated diagrammatically in Fig. 13 :—

1. A cylinder, in which works a piston connected in the usual way to a crank shaft. This cylinder, surrounded by a water jacket to keep it cool, is fitted with—*a*, an air valve; *b*, a fuel valve; *c*, an exhaust valve. All these valves are opened by a two-to-one shaft, driven by the engine, and generally closed by means of springs.

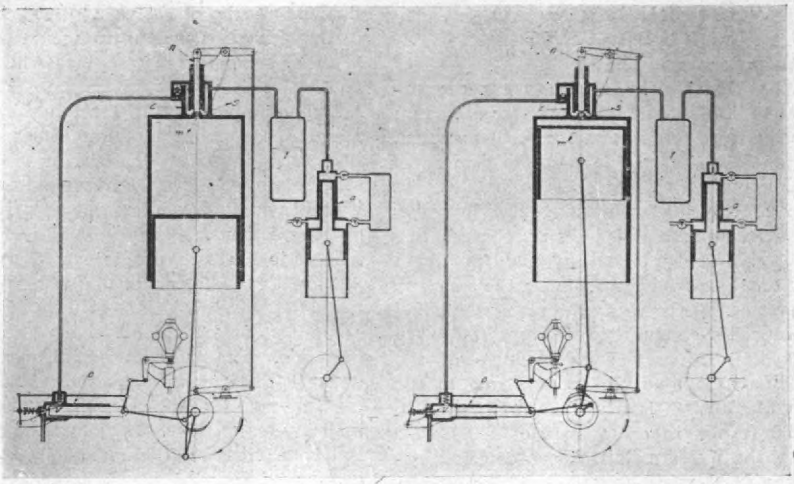

FIG. 13.

2. A fuel pump regulated by the governor.

3. An air-compressor to provide high-pressure air for pulverising and injecting the fuel.

In the case of the two-stroke Diesel engine, the essential elements are the same as those given above; the two-to-one shaft, however, runs at the same speed as the crank shaft of the engine, and a low-pressure air-compressor or blower has to be added for supplying the scavenging blast of air.

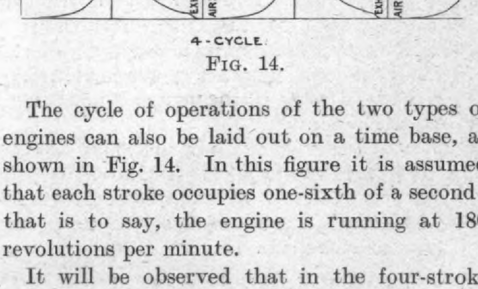

FIG. 14.

The cycle of operations of the two types of engines can also be laid out on a time base, as shown in Fig. 14. In this figure it is assumed that each stroke occupies one-sixth of a second; that is to say, the engine is running at 180 revolutions per minute.

It will be observed that in the four-stroke cycle the exhaust pressure is slightly above and

* See Cantor Lecture, "Internal Combustion Engines," by Dugald Clerk, M.Inst.C.E., p. 25.

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the air-suction pressure slightly below atmosphere. In the two-stroke cycle there is very little time for the exhaust and scavenge, and obviously the turning effort is far better than in the four-stroke cycle.

THE NATIONALISATION OF THE WESTERN RAILROAD OF FRANCE.*

Was the purchase by the State of the West of France Railroad caused by a desire to reduce expenditure and to improve the means of transit? No; but following the elections of 1906, M. Clemenceau, then Prime Minister, felt a desire to give some satisfaction to the Socialist and Radical-Socialist parties by "socialising" something. In November he handed in a proposal for the purchase of the Western line. What was the argument put forth in favour of State ownership? That the company would never be able to repay the sums which had been advanced to guarantee the interest. On December 31st, 1905, the indebtedness of the Western line amounted, in moneys due to the State, to 302,569,000 francs, and in interest to 117,300,000 francs, in all a total of 419,880,000 francs; but the Western Railroad possessed rolling-stock estimated at 351 millions. Subjecting it to a reduction of 30 per cent., the price to be paid would therefore have been 245 million francs. That difference of 174 millions was the great argument put forward by the redemptionists to hasten the purchase.

How could redemption protect those interests? The guarantee of interest to shareholders amounted annually to 11,550,000 francs, and was to come to an end in 1935; it was prorogated till 1951, and afterwards until 1956, reduced to 6,300,000 francs. The remaining sums due by the company were written down as being 7,122,000 francs, and not 174 millions.

The results of the management by the State were increased expenditure: the deficiency of the Western Railroad was, in 1903, 28,522,000 francs; that of the State, in 1912, was 83,675,000 francs; the increase of working expenses amounts to 72,304,000 francs, out of which the staff draws 52,296,000 francs. According to M. Pierre Baudin's report to the Senate, on a total of 67,967 persons employed, 36,816, or 54 per cent., were told off on sick leave, and it was necessary to increase the workers by 7,440 units. While working expenses from 1908 to 1912 have increased by 72,304,000 francs, the gross receipts have risen from 217,645,000 to 244,335,000 francs, the increase only representing 26,689,000 francs.

As for the effect on State credit, the Minister of Finance issued this year 4 per cent. bonds. At once the 3 per cent. fell to 93·65, and afterwards to 91·95.

The redemption of the West of France Railroad was a complete failure.

* Abstract of a paper read by M. Yves Guyot before the Economic Section of the British Association.

CO-PARTNERSHIP IN INDUSTRY.*

Profit-sharing is still a very rare thing in the aggregate of all business. Full details of existing schemes in the United Kingdom will be contained in the forthcoming report by the Board of Trade. Profit-sharing is distinguished from gain-sharing by the fact that the latter is a premium on efficiency, payable irrespective of the general financial results of the year. But it is less easy to distinguish profit-sharing from co-partnership. Two types of schemes are examined which claim this distinctive title:—

I. The Co-partnership Trust in Lever Brothers, Limited, soap-makers, of Port Sunlight, Cheshire, instituted in 1909.—The main features of the scheme are as follows: Partnership certificates are issued to qualified workers who sign the co-partnership agreement. These certificates entitle the holders to share in profits over 5 per cent. *pari passu* with the holders of the ordinary shares, and the dividends, which are paid into savings-bank account to individual co-partners, are freely withdrawable. The certificates have no market value, and the scale of annual issue (at present 10 per cent. on salaries and wages) is determined by the majority shareholder. The allocation of certificates is left to trustees (the directors), assisted by an advisory committee of workers. On retirement, partnership certificates are exchanged on certain terms for preferential certificates limited to 5 per cent. interest, which lapse at death. Workers who voluntarily leave the business or break their co-partnership agreement forfeit all rights in the scrip. In considering the possibility of imitation, regard must be had to the following points: (1) That the firm is an exceptionally successful one; (2) that it is the maker of a proprietary article; (3) that it has previously conferred other benefits upon its employees. Figures for 1911: Certificates issued and outstanding—A, Partnership, £275,429; B, Preferential, £23,302 (nominal value); dividend on A, at 10 per cent., £27,543; on B, at 5 per cent., £1,165.

II. Co-partnership in the gas industry, with special reference to the South Metropolitan Company.—Co-partnership began here in 1889, but since 1907 there has been rapid expansion, so that there are now thirty-six companies practising profit-sharing or co-partnership: total capital, £50,000,000; total of employees affected, 22,000. The financial side of the South Metropolitan scheme is based on a sliding-scale. For every 1*d*. reduction in the price of gas shareholders get a further 2*s*. 8*d*. per cent. of dividend, and co-partners a bonus of ¾ per cent. Officers and workers are included in the scheme. The present bonus is 8½ per cent., and the stock held by employees over £300,000. The bonus, which is the absolute property of the co-partner, is not paid in cash but reserved, half for savings account, withdrawable in special circumstances, and half for investment in the company's

* Abstract of paper read before the Economic Science Section of the British Association by C. R. Fay, M.A.

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stock. Similar provisions appear in the schemes of other gas companies, with minor modifications.

The advantages of the scheme are: (1) the addition to wages, (2) the promotion of thrift, (3) the creation of good feeling and a sense of co-ownership. Sir George Livesey (late chairman of the South Metropolitan) claimed that the scheme paid the masters no less than the men, and had its influence in reducing the cost of labour and the price of gas. It is difficult, however, to establish exactly this casual connection. The gas industry is peculiar, having a partial monopoly of supply and a steady demand. Also its stocks are, in general, not speculative.

In certain cases these schemes have been opposed by the trade unions. Co-partnership makes strikes improbable and (while the co-partnership agreement, current for three or six months, lasts) punishable under the Conspiracy and Property Act of 1875. But the agreements give security to the men also. The most powerful ties of co-partnership are to be found in the democratic machinery by which the scheme is worked. A co-partnership committee (composed of the chairman of the board of directors and twenty-six representatives of the board and twenty-seven representatives of the co-partners) manages the scheme and does other valuable work connected with accidents, superannuation, and insurance. Finally, the scheme safeguards the interests of consumers, who are peculiarly benefited when they are drawn from a working-class district.

Municipalities are liable to labour trouble, but co-partnership would be difficult to apply here, owing to the special nature of municipal finance. The Stafford Corporation (gas and electricity departments) practises gain-sharing only. Co-partnership, like syndicalism, emphasises the necessity of a closer connection between the worker and his work. But it is doubtful if special legislation, favouring co-partnership, would be of any value to the movement.

LIBERATION OF HYDROCYANIC ACID FROM LINSEED.*

A farmer considers linseed to be one of the safest cattle-foods, but the chemist has shown that linseed readily liberates hydrocyanic acid. The author has attempted to measure the rate of liberation of hydrocyanic acid from linseed under conditions somewhat similar to those occurring during digestion. The rate at which hydrocyanic acid is liberated from linseed depends upon many details, but among the many causes which retard the liberation of hydrocyanic acid, the degree of acidity is pre-eminent. So sensitive is the enzyme responsible for the liberation of hydrocyanic acid, that acidity only $\frac{1}{200}$ normal in strength is sufficient greatly to retard the liberation of hydrocyanic acid. Under no ordinary conditions can linseed liberate hydrocyanic acid in the acid juices of the stomach. When "mash" is used for feeding cattle, linseed is often left for a short time, sufficient to liberate much of the hydrocyanic acid contained in the glucoside of the linseed. In such circumstances "mash" might be dangerous, but the danger could be completely removed by making the "mash" slightly acid. Hay, straw, pulped roots, and many other ingredients of "mash" contain traces of acids which would generally be sufficient to check the rate of liberation of hydrocyanic acid. Hence, in practice, hydrocyanic acid is rarely liberated from linseed, either before or after eating.

* Abstract of paper read before the Agricultural Section the British Association by S. H. Collins.

ENGINEERING AND ÆSTHETICS.*

There are injuries which we may inflict upon the community other than those to health and physical comfort. Every one, even the least cultured, has some sense of the beautiful and the comely, and is affected by the aspects of his environment more than he himself can realise. The engineer, then, whose works needlessly offend even the most fastidious taste is acting contrary to the spirit of his profession, at its best. There has been far too great a disregard of æsthetic considerations in the everyday work of the engineer—we usually take a too exclusively utilitarian view of our calling. We should not be prepared to accept, as referring to the arts we practise at their best, the distinction drawn by a philosophical writer between "the *mechanical* arts which can be efficiently exercised by mere trained habit, rote, or calculation," and "the fine arts which have to be exercised by a higher order of powers." And I think it can be shown that a greater regard for artistic merit in our designs would not necessarily lead to extravagance, but, in many cases, would conduce to economy and efficiency. It is at least true—and much less than the whole truth—that greater artistic merit than is commonly found in our works could be attained with no sacrifice of structural fitness, or of suitability for the purposes they are designed to serve.

There was a time when engineers made desperate attempts to secure artistic effects by the embellishment of their productions with features which they believed to be ornamental. Fortunately the standard of taste has risen above and beyond this practice in the case of most members of our profession and most of our clients. We are all familiar with illustrations of philosophical instruments, and other mechanical contrivances of the early times, that vied in lavishness of adornment—though not in artistic merit—with those wonderful astronomical appliances hat were carried—as trophies of war!—from Pekin to Sans Souci. Many of us can remember a time when the practice had not altogether disappeared, even

* Extract from the Presidential Address to the Engineering Section of the British Association by Professor Archibald Barr, D.Sc.

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in the design of steam engines, lathes, and other products of the mechanical engineer's workshop. I well remember in my apprenticeship days the building of a beam engine that was a triumph of ingenuity in the misapplication of decorative features. In place of the mildly ornamented pillars and entablature of Watt's design, there was provided, for the support of the journals of the beam, a pair of A frames constructed in the form of elaborately moulded Gothic arches flanked by lesser arches on each side, while the beam itself, and many other parts, were plentifully provided with even less appropriate embellishments borrowed from the art of the stonemason. It is some consolation to remember that the clients for whom the engine was built were not of this country, and that the design itself was not a product of the workshop that was favoured with the contract to produce this amazing piece of cast-iron architecture. We have all seen wrought-iron bridges the unattractive features of which were concealed by cast-iron masks—in the form of panelling, or of sham pillars and arches with no visible means of support—that not only have no connection with the structural scheme, but suggest types of construction that could not, by any possibility, meet the requirements.

THE FRENCH SILK-WEAVING INDUSTRY AND ITS FUTURE.

While at one time Lyons was the unchallenged centre for silk textiles, the production of the looms of that district now has to compete with the silk fabrics of other countries. Twenty years ago it was publicly stated in Lyons that it would not be surprising if the weaving of fine silk damask, brocaded velvet, or a piece of cloth of gold would become a historical curiosity, and to perpetuate their manufacture would be as costly for the State as the maintenance of the Gobelins establishment. Although twenty years have elapsed since this statement was uttered, the weavers of Lyons are still able to make on their hand-looms fabrics that in skilled workmanship, richness of design, and purity of quality, are unsurpassed.

In order that silk-weaving in its most perfect form as known in Lyons may not become a lost art, vigorous measures are being taken to preserve from extinction the weaving of the fine textiles for which the district is famous. Silk manufacturers and municipal authorities and legislators are facing the situation in all seriousness. A committee was appointed by the Chamber of Deputies to study the demands relative to the condition of silk manufacture at Lyons, and the best means to be taken for transforming the old looms.

This committee was divided into three sub-committees, one of which devoted itself entirely to the question of weaving in Lyons, and made its investigations last year. This sub-committee reported that it would urge the Government to pass a law to improve the present state of the silk industry of Lyons. It was asked that an annual subvention of £20,000 be granted during a period of twenty years, to be placed at the disposal of a particular bank of master silk weavers of Lyons. This sum should be applied immediately to engage apprentices with the master weavers for the manufacture of high-class figured textiles for upholstery and other purposes. The apprenticeship is to be organised and controlled by the special bank in question. About £800 should be paid out as bounties to master weavers and to apprentices. The apprenticeship will last three years, and every three months an apprentice will receive pecuniary assistance, more at the beginning and less at the end of his time, because during the third year he will be in a position to earn something. According to the American Consul at Lyons the total amount allowed to each apprentice will be £14. A master weaver will receive a certain amount every three months, beginning with about £5 for the first payment and gradually decreasing until in the last quarter of the third year he will receive 16*s*. 8*d*.

The sum of about £10,000 is to be set aside annually for the construction and fitting up of fifty workshop dwellings at about £200 each for Lyons weavers. About £6,400 is to be expended on the gradual transformation of hand-looms into power-looms and the eventual improvement of the latter. Such looms or improvements will be sold to weavers at half price, and the money to purchase them will be lent without interest. About £7,300 is to be devoted to pensions and other aid to aged master weavers and their wives. These various sums mentioned make an aggregate of about £24,500 annually, but will be reduced by repayments of money advanced in the construction of workshop buildings. It is further asked that the proper Government authorities be empowered to order silk textiles for furnishing the national palaces in France, and French embassies and consulates, to the amount of £400,000. This sum will be extended over a period of twelve years from 1911 to 1922, with a privilege of carrying from one year to another any sum not disbursed. It is to be stipulated in giving the orders that wages and amounts for piece-work are to be paid according to the tariffs approved by a council of experts.

Further, the creation is demanded at Lyons of a so-called conservatoire in the interests of the silk industry, in which will be incorporated an atelier for permanent demonstration in the practical phases of silk-weaving. This atelier will serve as well for the instruction of apprentices. An experienced silk manufacturer of Lyons has drawn up the plan in all its details for the new conservatoire. In presenting the project it was called to mind that generations of weavers and employers, of whom a number became manufacturers, sprang from old-time ateliers that took the place of an open technical school. The popularisation of the silk industry and the introduction of the power-loom, with women employed for the weaving, have brought about a gradual disappearance of the large ateliers, and finally of the smaller ones. This

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circumstance, which caused the creation of the present unpretentious weaving school, is to be the starting-point of the vast atelier, which will be known as a conservatoire of the arts of the silk industry. This will be in a sense a national institution, and will be a means to keep the famous French industry in the forefront of the world's manufactures. In the new conservatoire there will be ten entirely independent ateliers, each one with a hand-loom for making high-class figured silks, with all the necessary departments found in an extensive and thoroughly modern silk-weaving mill. If the new conservatoire is to be apart from the weaving school, a large hall will serve as a museum.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Dimensions of the Textile Industries.—A notion of the immense dimensions of the British textile manufacturing industries is obtainable from a comparison of the textile with the agricultural output. Agriculture, traditionally the greatest of British industries, is credited in the latest official returns with a gross output of £150,800,000 during 1908 in Great Britain only. Textile factories were given credit for £327½ millions in 1907. The amount includes the textile productions of Ireland, but the subtraction of these leaves a sum of £314 millions, and the total is confessedly incomplete. Agriculture employs 1,173,000 permanent labourers, and textile work 1,060,500 persons. There was casual labour on the farms which at June 4th, 1908, added 167,000 to the total, and there were half a million occupiers, of whom some must be classed with the permanent workers. With all allowances on this score the sheer magnitude of textile operations will still seem impressively large. This effect is heightened by contrast with the 854,600 at work in and about coal mines in 1907, or the 945,900 engaged in the building trades, recorded in the census of 1901.

The Textile Institute.—These huge proportions imply a large public intimately interested in textile affairs, but by process of specialisation any one person is interested deeply in relatively a small segment of the proceedings. The difficulty of discovering matter of common interest to men engaged in different textile trades or in different branches of the same trade is speedily found by those who address themselves to the whole. This is one of the intrinsic troubles incidental to the working of such a body as the Textile Institute, which set forth a couple of years ago with intent to be to textile industry all that the most successful institutes have been to the metal trades. In part the difficulty has been rounded by making the Institute peripatetic, and holding congresses by turns in Manchester, Bradford, Belfast, and last in Hawick. Every centre of the industry has a life and interests of its own, apart from that shared by districts in common, and only by separate application to each can attention be enlisted. Thus at the Hawick meeting the programme was arranged with an eye firstly to the local interest in tweeds and hosiery, wool and wool yarn, and, secondly, to the universal interest in the respective advantages of steam, gas, oil and electricity as sources of power.

Scotch Tweeds.—Of the papers read at Hawick, that of Mr. Thomas Welsh upon the Scotch tweed manufacture had the widest popular appeal, and his account of the origins and progress of this large and now lucrative industry may prompt others to recall the steps in the evolution of their own. Mr. Welsh attributed the fashion of wearing tweeds to the daring of an obscure innovator, who had an old shepherd's plaid converted into trousers. Shepherd's checks—or "Sheppard's" checks as some say they should be spelt in memory of a deceased weaver — have their periodical vogues still. The black and white commended itself to Sir Walter Scott, and became a regular part of Sunday apparel. The accidental discolouring of the white in one batch of pieces stimulated the owner to dye the goods brown, and the new black and brown caught the public fancy. One colour led to another, and gradual and tentative experiments in design brought into being the infinitely various and complex patterns of to-day. The cloths were worked out first in the wools of the locality, as cheviot cloths are still. Mr. Welsh gives 1833 as the date at which fine foreign wools began to be used, and, although Scotland now receives its fine wool from Australia, the old name Saxony, conferred by the use of Saxony merino, still distinguishes fine cloths from coarser ones. Scotch tweeds owe their renown, half to the unimpaired excellence of their quality and half to the cunning with which their colourings have been devised. For inspiration in colour effects one early manufacturer went to the granite, porphyry and jasper of the Pass of Killiecrankie, while others went to the neighbouring hills for heather and grasses embodying colour contrasts capable of reproduction in dyed wool. The evidences of natural derivation are apparent in the cloths of our own day, but it is simple truth to add that some have a more prosaic origin. Dyers tell of snatches of wall-paper, threads of silk, and even samples of soft soap, sent to them to illustrate the colour or combination that the designer would be at.

Sources of Design.—If the origins of textile colourings are sometimes bastard, so also are the elements of design in ornately figured woven and printed goods. No source is despised, and consequently it is possible to enter a public designer's room and find there picture posters exhibiting the masses and contrasts that one client wishes him to imitate. At another time, vases are sent on loan for the sake of the decorations they exhibit. Picture postcards, supplements of the British and foreign art papers, lithographs, engravings, and, of course, photographs serve to supply raw material. All is fish to the handymen who, in the course of

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satisfying the home and foreign public taste, have inevitably to descend to depths not approved by masters and amateurs of art. There are two ways of regarding the concessions that are made to public predilections, and it would be wilful to deny recognition to the merits of some of the work that escapes from ateliers that are responsible also for some of the most rococo productions. Public designing for textile purposes is done more largely in France than in England, and there is always an importation into this country, America and Germany, of Parisian designs. French and German designers have been brought in a few cases to English workshops, and their individual or co-operative works have sold to France. Apparently French manufacturers are more concerned at present to get strong and rugged designs than weakly pretty ones. Their own men have more than all the neatness that is required, but lack in the breadth of treatment that is distinctive of some English work.

Cosmopolitan Cloths.—Taste and design are not more cosmopolitan in the textile world than the material part of woven productions. Cotton comes here from America or Egypt to be made into yarn for export to another country where the weaving is done. Some of it, woven into cloth, is sent to Switzerland to be embroidered, or to Holland to be printed, either to be returned here or re-exported to some other market. The case is similar with wool. Bradford receives and combs wool for Germans, Japanese, Scandinavians and Italians to spin, and sends forty or fifty million pounds of worsted yarn to Germany to weave. Belgian woollen yarn arrives in heavy quantities in this country to make Bradford dress goods and Glasgow shirtings, and Belgian cotton yarn sells to a small extent to make Nottingham curtains. Italy has long supplied our manufacturers with spun silk, and now Japan is sending to this market spun waste silk yarn of somewhat uneven quality at a shilling a pound less than the price for which yarn of similar length can be got from other sources. Between the foreign cloths made from British materials and the British-made cloth from imported yarn, the national origins of a large part of the world's production are notably mixed. The export of half-finished goods has been jealously regarded by manufacturers of cloth, and the quick growth of the foreign trade in the less advanced productions has pointed many complaints as to the state of the industry. But cloth, in the overwhelming majority of instances, is not a fully-manufactured commodity, and until it becomes a robe or a suit is not complete for consumption. Thus, if the cloth manufacturer has his grievance against the export of yarn, so also has the clothing manufacturer against the export of cloth. Both here and abroad manufacturers find they can weave that which they cannot economically spin or get spun in their own countries. Yarn production is increased by spinners, more or less, in accordance with the demand, and without reference to the nationality or situation of those who will do the ultimate weaving or knitting.

The Carpet Industry.— The manufacture of carpets, although closely associated with woollen and worsted manufacture at large, constitutes a fair-sized *imperium in imperio.* At any rate, two of the large carpet mills in this country have undergone recent extension on a considerable scale, and the export of carpets continues to expand. No doubt the gross production of this branch has increased since 1907, when it was returned at appproximately £4 millions. Nearly one-fourth of that total has been recorded already in the export returns for the first eight months of this year. Canada, which has its own carpet works, some of them in the ownership of Kidderminster firms, and Australia, are at present the principal oversea markets. Extensive additions have been made to a mill already large, owned by a Yorkshire firm in the United States. Apparently seamless squares in Wilton, chenille Axminster, and other Axminster makes, are proving profitable to manufacturers, and their popularity is manifest in the homes and the shops. The dominance of the taste for Oriental colourings and designs is marked strongly in all forms of pile carpet. More independence is shown in the Roman or art squares both in the matter of decoration and colour. Self-coloured mohair rugs, made by plush manufacturers, have established their place among the productions of the carpet mills proper. The carpet trade is good, despite the incessant advances of its great competitor, linoleum.

NOTES ON BOOKS.

Signatures in the First Journal-Book and Charter-Book of the Royal Society. Record of the Royal Society. Printed for the Royal Society. London. 1912.

These two handsome volumes were published in commemoration of the 250th anniversary of the foundation of the Royal Society of London. The first-named is specially interesting and valuable, because it contains facsimiles of the signatures of all the Fellows of the Royal Society from its foundation to the present time, with the exception of course of the comparatively small number of those who never signed the Charter-Book, every page of which has been carefully reproduced by photography and reprinted in the original size.

This edition of the Record Book is a reproduction, with additions, of the work which first appeared in the year 1897, the object of which was "to provide a compendium of information, largely historical, regarding the rise and progress, the organisation and work of the Royal Society." It was originally proposed that new editions should be issued every five years, but eventually it seemed that this was unnecessary, much of the information being given

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in the Society's Annual Year-Book. A second edition was published in 1901, and the present is the third. It contains a chapter on the foundation and early history of the Royal Society, the Charter and Statutes, the Trusts, and full information about the Society's committees, publications, and the funds which it administers. There are also lists of the medallists, and some account of the relics, portraits, busts, and medals in the possession of the Society. There are two lists of the Fellows —one in chronological and the other in alphabetical order.

It will be seen that this Record to a large extent supplies the need which has often been remarked upon for a complete history of the Royal Society. There are actually four histories of the Royal Society, but none of them of modern date. The first by Thomas Sprat, Bishop of Rochester, which was published in 1667, although it contains a certain amount of information, was rather a defence of the Society against attacks of the *a priori* philosophers than a true history. Birch's history, published in 1756, leaves off at 1687. It is rather a history of scientific progress in England during the latter part of the seventeenth century than of the Royal Society itself, though it gives an account extracted from the manuscript records of the subjects brought before it, and is no doubt a work of very great value. Thomson's work appeared in 1812—it was valuable chiefly for the lists of Fellows contained in it, and in this it has now been superseded. Weld's history of the Royal Society, published in 1848, is perhaps the book upon which everyone who would study the past history of the Society has to rely. But it does not bring the narrative down beyond 1830, and the copious materials which his industry collected are ill-digested and ill-arranged. There are, of course, short accounts of the Royal Society to be found in the various encyclopædias—the one in Knight's English Cyclopædia is specially interesting, because it is believed to have been written by Professor De Morgan.

Full material for a history is to be found in the annual presidential addresses which are printed in the Royal Society's proceedings, and it would be an interesting piece of work if anyone would take the materials contained in them, in the Record, and in the histories above referred to, and would produce from them a fairly compendious history of the Royal Society down to the present date.

Parallel Paths. By T. W. Rolleston. London: Duckworth & Co. 2*s*. 6*d*. net.

Mr. Rolleston's study in biology, ethics, and art was first published in 1908, and its reappearance in its new and cheap form is to be warmly welcomed. There is no need to criticise the matter of the volume at the present day, for the author's well-known philosophical insight and scientific learning have won it a well-recognised position in the world of books. One may, however, offer a word of congratulation to the publishers on the Readers' Library, of which this volume forms a part. The series now contains a number of works of remarkable interest; the books are excellently printed, they are bound in a tasteful and workmanlike style, and offer excellent value for the very modest price asked for them.

The Origin and Evolution of Primitive Man. By Albert Churchward, M.D., M.R.C.P., F.G.S. London: George Allen & Co., Ltd. 5*s*.

This little volume is a reprint, with some additions, of a lecture delivered by the author at the Royal Societies Club last winter. Dr. Churchward is fully convinced that "the preconceived ideas of many scientists as to the origin of the human race—as regards both time and place—are erroneous." He himself would place the cradle of the race in central Africa, and primitive man in the Pygmies, who, he thinks, are not a degenerate race, but an undeveloped one. The evolution of man he traces from this source through the Bushmen, the Masaba Negro, the Nilotic Negro, the Masi, the Mongoloids, to the so-called Aryanists.

Dr. Churchward has evidently devoted much attention to the study of the Pygmies, their anatomy, their customs, beliefs, and language, and what he has to say about them is extremely valuable. A large number of illustrations add materially to the interest of the lecture.

GENERAL NOTES.

Public Health Research.—At the close of this month the extensive new laboratories of public health and bacteriology, recently formed by the Charing Cross Hospital Medical School, and taken over by the University of London as the public health and bacteriological department of King's College, will be formally opened and handed over to the University. The laboratories are situated in Chandos Street, Strand. They include a large class laboratory, research, professors' and lecturers' laboratories for the departments of public health and bacteriology respectively, preparation and animal rooms, a large theatre, and a library for the joint use of the two departments. The regular courses of instruction in bacteriology, clinical pathology, and photomicrography, and for the diploma of public health, will be given there, and research and investigation work for public bodies and others will also be carried on.

Rubies.—Mr. Noel Heaton, who, it will be remembered, read an extremely interesting paper on "The Production and Identification of Artificial Stones" before the Society some eighteen months ago, has written a small pamphlet on "Rubies," which is published by the Burma Ruby Mines, Ltd. He briefly explains what a natural ruby is, and how it may be distinguished from other similar stones, and especially from reconstructed

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and synthetic rubies. Some excellent coloured illustrations demonstrate the differences between the various kinds of stone with great clearness. A case recently tried in the law courts showed what extraordinary confusion on the points dealt with by Mr. Heaton exists even in the minds of those who are supposed to be experts on the subject, and the pamphlet should prove of great service to jewellers and dealers in precious stones.

THE U.S.A. HARVEST. — The reports of the harvest in the United States of America continue to be very favourable. Dr. Henry Clews, the well-known American financier, writes: "A total wheat crop, closely approximating 700,000,000 bushels, is now reasonably assured, which is a total that has but twice been exceeded, namely, by the 735,000,000 bushel yield of 1906 and the 748,000,000 bushel harvest of 1901. Spring wheat this year is making a magnificent showing, being estimated at 300,000,000 bushels, which compares with a yield of 190,682,000 bushels in 1911. This excellent showing more than compensates for the poorer showing of the winter wheat crop, which resulted from the unusually severe winter of 1911–12. Oats and hay are far in excess of the yields of earlier years, which will, of course, release for export a considerable amount of corn that would otherwise have been required for feed on the farm. Cotton cannot be expected to approach the extraordinary yield of last year, but according to present promises, will probably not fall far short of 14,000,000 bales, if, indeed, it does not exceed that total."

THE SMOKE NUISANCE.—A bulletin recently published by the Department of Industrial Research, University of Pittsburgh, gives some interesting details of an investigation which is now being carried out in that city into the smoke nuisance. The Director of the Department, Professor Robert Kennedy Duncan, who is a distinguished member of this Society, has received from a private donor a fund for the purposes of the investigation. At the present moment the inquiry is being conducted by a staff of twenty-five specialists, six of whom are giving their entire attention to the work, while the remaining nineteen have been entrusted with the preparation of special reports concerning particular phases of the subject. Among these are such questions as the effect of smoke upon weather, upon vegetation, the chemistry of smoke and soot, the deterioration of buildings and building materials in smoky atmospheres, smoke and disease, the cost of the smoke nuisance, the question of legal regulation, etc. Under the direction of Professor Duncan, the investigation will, no doubt, be extremely thorough, and the results ought to prove of great value. Not the least interesting part of the work will be an attempt to educate public opinion in the matter. It is proposed to make a systematic effort to enlighten civic and business organisations, and to arouse them to combined action. A staff of lecturers will be organised to address such organisations in Pittsburgh and elsewhere; efforts will be made to secure the co-operation of the public press, and finally the results of the whole inquiry will be published in book form.

DEMAND FOR ITALIAN-MADE GOODS IN SOMALILAND.—According to a communication recently received by the Administration of the Commercial Museum (*Museo communale*) of Milan from the Italian authorities at Mogadisco (Somaliland), there appears to be a demand for Italian-made goods in that country. Amongst the principal articles which are required by the government of the colony at the present time, may be mentioned building material, bricks, cement, timber, ironwork, ironmongery of every description, rails and material for light railways, motors, agricultural, pumping and other machinery, paint and varnishes, printing material, stationery, rope, cordage, cotton goods, etc.

THE COMMERCE OF NAPLES.—The value of the export and import trade of Naples has increased considerably during the last three years, as will be seen by the following statistics recently published by the Chamber of Commerce at that port—

Exports.

	Lire.	£ sterling.
1909	99,648,989	3,985,959
1910	111,299,000	4,449,960
1911	161,484,510	6,459,380

Imports.

	Lire.	£ sterling.
1909	248,712,010	9,948,480
1910	265,499,256	10,619,969
1911	290,846,560	11,633,862

This shows an increase in the value of the exports of 50,185,510 lire (£2,007,420), and of 25,347,304 lire (£1,013,892) in the imports of 1911 as compared with 1910. The exports last year were chiefly macaroni and other kinds of Italian paste, to the value of (in round numbers) eighteen million lire (£720,000); fruit and vegetables preserved in salt, oil or vinegar, fifteen million lire (£600,000); manufacture of coral goods, fifteen millions (£600,000); preserved tomatoes, ten millions (£400,000); cheese, ten millions (£400,000); cattle, eight millions (£320,000); raw hemp, seven millions (£280,000); manufactured tobacco, five millions (£200,000); flour, dried fruit and wine, four millions (£160,000) each. The imports during the same year consisted principally of grain to the value of forty-four million lire (£1,760,000); hard wheat, used exclusively for the manufacture of macaroni, thirty-eight millions (£1,520,000); coal, twenty-two millions (£880,000); cotton, fifteen millions (£600,000); dried fish, twelve millions (£480,000); machinery and parts of machines, eleven millions (£440,000); raw hides, nine millions (£360,000); copper and its alloys, in ingots, seven millions (£280,000); iron and steel plates, five millions (£200,000); sulphate of copper, dressed hides and cotton goods, four million lire each (£160,000).

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Journal of the Royal Society of Arts.

No. 3,125. VOL. LX.

FRIDAY, OCTOBER 11, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

"OWEN JONES" PRIZES FOR INDUSTRIAL DESIGN.

The Council of the Royal Society of Arts hold a sum of £400, the balance of the subscriptions to the Owen Jones Memorial Fund, presented to them by the committee of that fund in 1876, on condition that the interest thereof be spent in prizes to "Students of Schools of Art who, in annual competition, produce the best designs for household furniture, carpets, wall-papers and hangings, damasks, chintzes, etc., regulated by the principles laid down by Owen Jones."

Competitions under the terms of this Trust have been held annually since 1878.

The next award will be made in 1913, when six prizes are offered for competition, each prize to consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The prizes will be awarded on the Report of the Examiners in the National Competition of the Board of Education. The designs must be submitted in the usual manner to the Board of Education by April 1st, 1913. They must be marked "In Competition for the Owen Jones Prizes," and must comply with the regulations of the Board of Education. The exact address to which the work should be sent will be communicated later to the schools by the Board of Education.

No candidate who has gained one of the above prizes can again take part in the competition.

In the competition held in 1912, 490 works were submitted, the best examples being in woven, printed and stencilled fabrics. Some good designs in damasks, carpets, embroidery and lace were also submitted.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

HEAVY OIL ENGINES.

By Capt. H. Riall Sankey, R.E. (Retired), M.Inst.C.E.

Lecture II.—Delivered May 6th, 1912.

Design of Diesel Engine.

As already stated, the essential part of the Diesel engine is the fuel valve, and it requires special design; the other valves are like those adopted for gas engines, and the method of driving them is substantially similar. All the other parts, a list of which will be given later, are similar to the corresponding parts of a steam or of a gas engine, and in a general way their design follows that adopted for those engines.

The differences are mainly those of dimensions, brought about by the far greater pressures that have to be withstood. As regards the cylinder, in the case of a steam engine the high-pressure cylinders have to be designed for working pressure of from 150 lbs. to 200 lbs. per square inch, whereas, both in gas and Diesel engines, working pressures of at least 500 lbs. per square inch have to be considered.

The dimensions of connecting-rods and crank shafts depend on the maximum forces applied to them, and not on the average forces, and both in gas and Diesel engines the ratio of the maximum to the mean force is far greater than in the case of the steam engine; this leads to greater scantlings. Occasionally, however, the parts of all these engines may have to withstand much higher stresses, due, in the case of the steam engine to water hammer, in the case of the gas engine to pre-ignition, and in the case of the Diesel engine to a charge remaining in the cylinder unignited and causing an explosion at the top of the next stroke, thus increasing the

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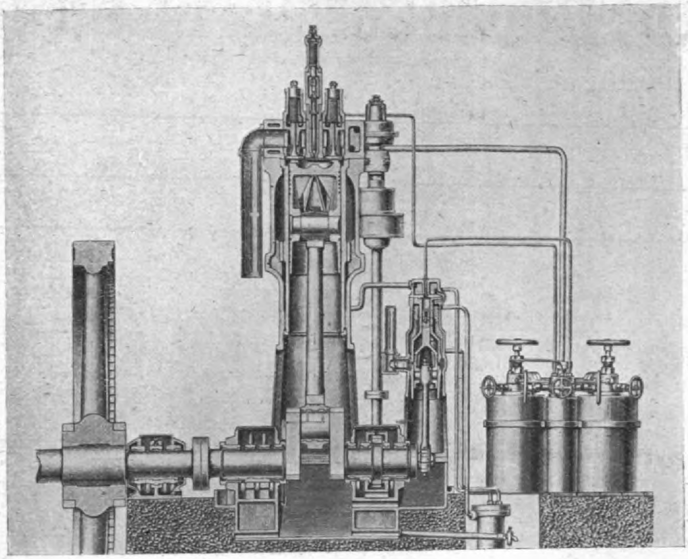

FIG. 15.

The large number of different designs that can be produced by combining two or more of these various types is obviously very great, and at present the process of selection is going on.

There would not be time to go seriatim through all these various types, but a few of them will be described in a general way and illustrated later. A good idea of the general design can be obtained by studying the more usual arrangement adopted for a single line vertical four-stroke slow-speed Diesel engine of 100 B.H.P., of the kind now being manufactured by a very large number of firms in this, and other countries.

In this design the engine is single-acting, and the piston is of the variety known as a trunk piston, which also acts as a guide, so that no piston rod or cross-head guide is required, and the cylinder can be placed much nearer to the crank shaft, thus reducing the height of the engine materially.

The vertical section of such an engine is

pressure to about 1,700 lbs. per square inch. So long, however, as the stress thus produced is sensibly below the elastic limit of the material no harm will be done.

It will be gathered from the above that the thickness of cylinder walls, the strength of cylinder covers, studs for securing the cylinder covers to the cylinders, the framework generally, the connecting-rods, and the crank shaft, will be much greater in the case of the Diesel oil engine than in a steam engine of equal power running at the same speed. These increased scantlings of the Diesel engine produce a feature which immediately attracts attention.

Apart from the power to be developed, the design and dimensions depend also on the type of Diesel engine under consideration, and these may be classified as follows:—

- Slow speed, 100 to 200 revolutions per minute.
- High speed, 300 to 600 revolutions per minute.
- Vertical or horizontal.
- Four-stroke, single acting or double acting.
- Two-stroke, single acting or double acting.
- One, two, three or more lines (an eight-line engine has already been constructed).

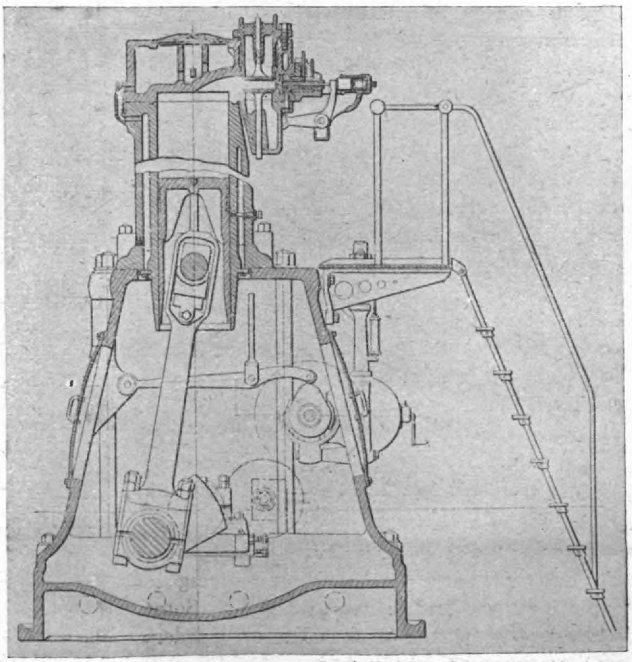

FIG. 16.

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given in Figs. 15, 16, 17, and 18, and the various important parts are as follows:—

1. The base.
2. Bearings.
3. Lubricating pump.
4. Crank shaft.
5. Fly-wheel.
6. Framing.
7. Connecting-rod and its bearings.
8. Trunk piston.
9. Piston rings.
10. Cylinder and jacket.
11. Cylinder cover.
12. Two-to-one shaft.
13. Levers for actuating valves.
14. Special air valve levers for starting.
15. Fuel valve.
16. Exhaust valve.
17. Air suction valve, and pipe.
18. Air-compressor.
19. Compressed-air vessels.
20. Fuel pump.
21. Fuel tank.
22. Governor and its drive.
23. Exhaust pipe and silencer.

In the design shown in Figs. 15, 17, and 18, the walls of the jacket cylinder form part of the framework of the engine, thus connecting the cylinder cover through the A frame to the base and making a fixed link in the kinematic chain, known as a slider crank chain, to which all such reciprocating engines belong. In Fig. 16 the jacket cylinder is bolted to the A frame, or rather to the crank chamber. The former is the more usual design for slow-speed engines, and is adopted by Sulzer, Willans and Robinson, Burmeister, and Wain, and many other builders, even for large engines; and in this case the engine is not enclosed, the A frame itself forming the necessary shield to prevent the splash of the lubricating oil. There does not seem to be any special reason for adopting a closed crank chamber in the case of slow-speed engines, and the open frame has many advantages, such as easier inspection whilst running, greater ease in getting at parts for repairs, and greater ease for the heat to radiate, thus keeping the bearings cooler. In the cases referred to above, the cylinder proper is formed as a liner, and can be removed by taking off the cylinder cover and

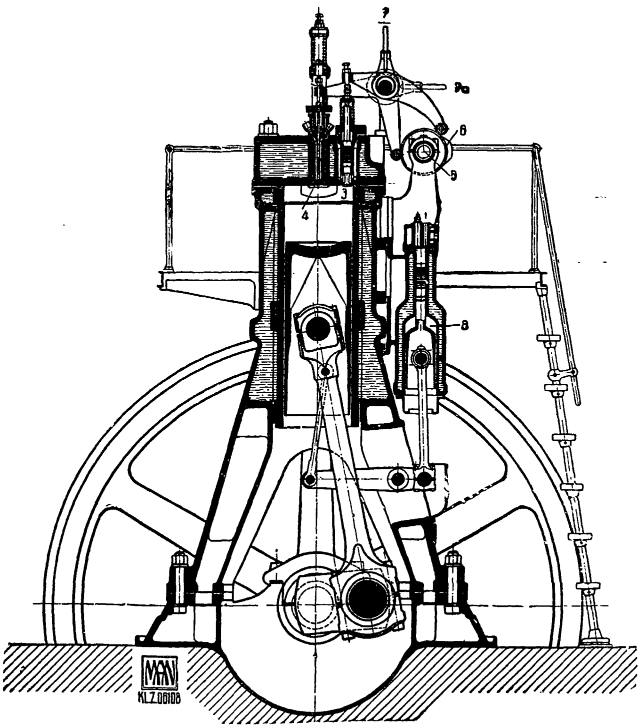

Fig. 17.

Each of these parts will now be considered in the order named, and at the same time some of the modifications that are made by various constructors will be described.

without dismantling the engine. In some cases the cylinder and liner are formed in one casting, bolted to the A frame or to the crank chamber, as, for example, in the marine engines made

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by the Maschinenfabrik Augsburg - Nürnberg Company.

1. *The Base.*—This is in the form of a box-casting, with holes through it for bolting to the foundations. There are facings machined to take the flanges of the A frame or crank chamber, and seatings are machined for the bearings. In engines of 1,000 h.p. and upwards, Messrs. Krupp, Sulzer, and Carels, make the base in segments, bolted together *in situ.*

3. *Lubricating Pump.*—When forced lubrication is used, which is the arrangement adopted with closed crank-chambers, practically any type of forced lubrication pump will do. The various makers have their own design on which they rely. The oil pipes connecting the lubricating pump to the various bearings are usually made of copper. The oil flows back into the base, and after being strained returns to the pump. Some makers have an independent pump for

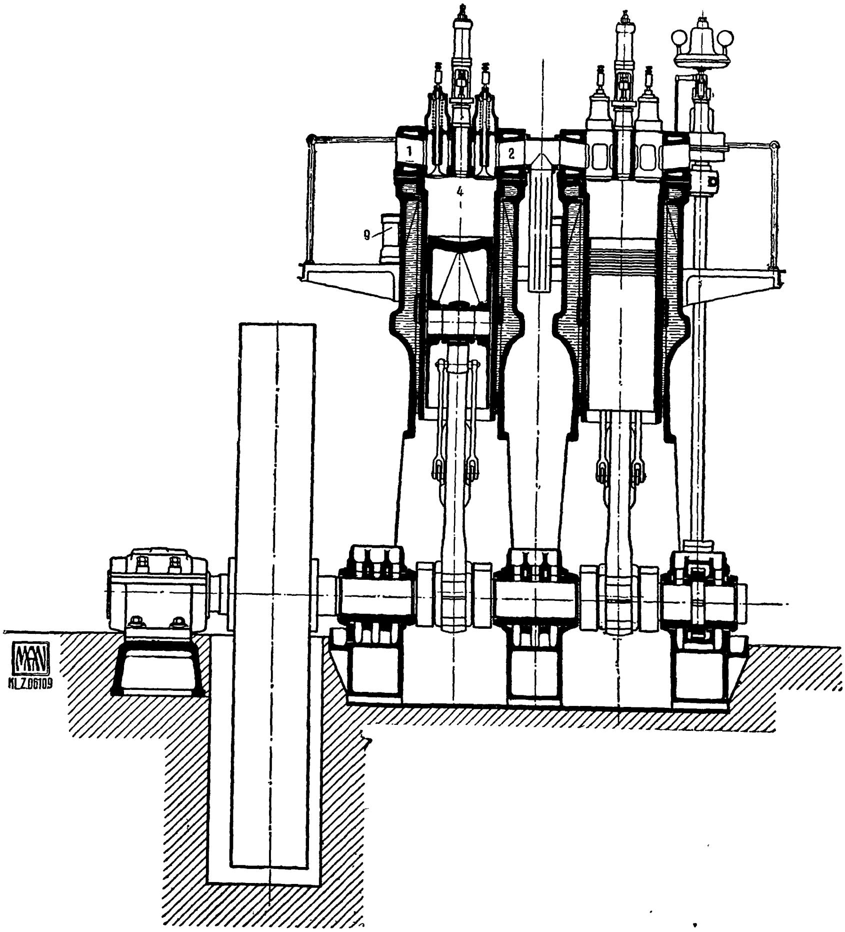

FIG. 18.

2. *Bearings.*—The bearings for the crank shaft are usually of white metal in cast-iron or steel shells. The white metal is continuous over the whole bearing, and the shell must be carefully tinned so as to obtain good metallic contact between the white metal and the shell, in order to reduce the heat resistance which would otherwise exist between the surfaces of the two metals, so as to conduct away the heat which is produced by the friction of the bearings.

lubricating cylinders, in which case the oil is forced through small holes at the base of the liner at the end of the working stroke. The bearings at both the big and small end of the connecting-rod are forced lubricated, but in small and medium engines the crank shaft bearings are lubricated by means of a ring; in large engines these bearings are also forced lubricated.

4. *Crank Shaft.*—Forged nickel steel is used by many makers. As already pointed out, the

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crank shaft of the Diesel engine is subject to greater inequality of torque than that of the steam engine; it is also subject to heavy shearing stresses, and in the case of single-acting engines to reversal of stress. Thus much larger diameters are required, in the same way as was found to be necessary in the case of the Willans' engine, and the effect may be gathered from the following. A shaft transmitting 100 h.p. at 200 revolutions per minute by pure torque, *i.e.*, when there is no bending stress, should be 2·6 in diameter; but when exposed to the maximum bending stresses likely to occur in practice, the diameter must be increased to 4 ins., and the latter may be taken as the conditions of working for an ordinary steam engine crank shaft. To meet the requirements of the Diesel engine, as stated above, the diameter of the shaft should be at least 10 ins.

5. *Fly-wheel.*—The fly-wheel of a Diesel engine, like that of a gas engine, must contain sufficient energy to maintain the velocity fairly constant in spite of the want of uniformity of torque indicated in Fig. 14. Four-stroke engines require larger fly-wheels than two-stroke engines, and the fewer the cylinders the larger the fly-wheel must be. To give some idea of the size of the fly-wheel, it may be stated that a two-line four-stroke 250 B.H.P. engine, running at 200 revolutions per minute, requires a fly-wheel weighing fifteen tons, and since the weight of the engine itself is forty tons, it will be seen what a large proportion the weight of the fly-wheel bears to that of the rest of the engine. The stored energy in this fly-wheel is 4,320,000 foot lbs., or at the rate of about 17,000 foot lbs. per B.H.P.

Owing to the want of uniformity of the torque, the fixing of the fly-wheel shaft has to be effected with special care.

6. *Framing.*—In Figs. 15, 17, and 18 the A frames are of cast-iron box section, often fitted with splash-guards, and this is the usual construction with slow-speed engines. Sometimes a single casting, forming a crank chamber, takes the place of the A frames when an engine has several lines; this is always the case with high-speed engines. Facings are machined at the feet to marry with the facings machined on the bed, and if the jacket cylinders are separate, facings have to be machined on the top of the A frames as well.

7. *Connecting-rods.*—Solid forgings of good quality carbon steel are used; the big end for land engines is generally of the flat-footed type to bolt on to the big end-bearings or brasses. These brasses are often made of phosphor bronze, but many makers use steel shells lined with white metal. The small end is often slotted out to carry a special split phosphor bronze bearing, and a screw adjustment is fitted so that the length of the connecting-rod can be altered within small limits to adjust the compression accurately. When an open A frame is used, the lubrication of the small end is effected by means of a hole drilled through the gudgeon pin, which comes opposite a slot in the cylinder at the bottom of the stroke, and at this moment the lubricating pump squirts in a supply of oil. For the smaller engines a connecting-rod of circular section is used; for high-speed engines, in order to obtain lightness and better distribution of the material, a round section with flattened sides is employed, and some makers have even gone to the expense of using flat rods milled out so as to obtain an H section, which, of course, is theoretically the best section for resisting the transverse inertia stresses. Such a section, however, can only pay commercially with high speeds and when great lightness is a necessity. The big end-bearing bushes are of similar design to those adopted for steam engines, the only difference being their greater weight for the same horse-power.

8. *Trunk Piston.*—The trunk pistons are made of cast-iron, generally in one casting; they are ribbed inside for strength and for cooling, and a through hole is provided for carrying the gudgeon pin of the connecting rod, as shown in Fig. 16. The top is generally curved so as to relieve the stresses produced by the heat, and this shape of top has probably the effect of producing eddies, which increase the rapidity of combustion. This question of eddy-forming or turbulence is one which has only recently been noticed, and some experiments made a short time ago by Mr. Dugald Clerk and Dr. Bertram Hopkinson showed that in the case of the gas engine it is a most important factor in promoting rapidity of explosion. This is a matter which will have to be studied more closely in connection with the Diesel engine.

The maximum diameter of trunk piston that can be safely run without water- or oil-cooling is 24 ins. Above this diameter it is necessary to arrange for a water circulation or for an oil circulation. Messrs. Sulzer adopt an arrangement whereby oil is squirted on to the under side of the piston at the top of the stroke; the oil then falls in a shower into a cup, whence it is conducted to the connecting-rod to lubricate the small end.

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The piston body is grooved for the piston rings, and is extended to form a guide. There are also grooves without rings placed at the bottom of the extension, to hold the lubricating oil. Messrs. Krupp and Messrs. Sulzer water-cool the top end of the piston in large engines, and have adopted an arrangement which gives no dynamical action, and there are no glands on the pipes. The large marine engines of the Maschinenfabrik Augsburg-Nürnberg Co. are oil-cooled. The gudgeon pin is made of case-hardened steel, and is fixed in the piston body. Special care has to be taken to ensure that it is accurately placed in the piston body so as not to produce any cross strains, either in the piston or in the connecting-rod, and these arrangements have to be such that the pin can be easily withdrawn

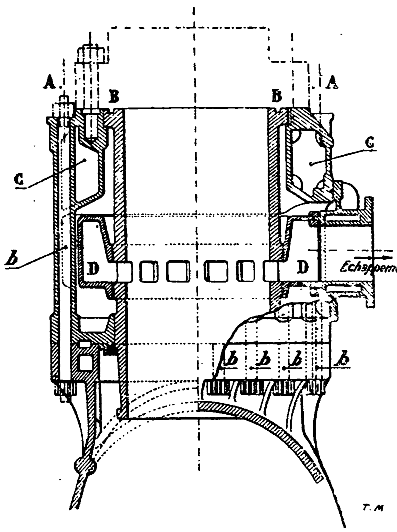

Fig. 19.

for repair or renewal. Usually the length of a trunk piston is 1·8 times the diameter. A considerable clearance has to be allowed between the piston body and the cylinder; only experience can tell what this amount ought to be.

9. *Piston Rings.*—These are of the usual Ramsbottom type placed in the grooves in the piston body. Messrs. Sulzer adopt a special arrangement for machining these piston rings to get uniform pressure at all points; it is the same arrangement which they have adopted for years for steam engine piston rings.

10. *Cylinders and Jackets.*—The general design of these has already been referred to, and can be seen from the figures.

When the jackets are separately cast they are flanged at the lower end to bolt to the top of the A frame. Great care must be taken to machine these facings truly perpendicular to the axis, else difficulties will arise in running the engine. The studs have to be very large; in the case of a 20-inch cylinder, for example, eight studs, $2\frac{1}{2}$ inches diameter are required. A special cast-iron mixture, suitable for resisting high temperature, is required for the cylinder liners.

11. *Cylinder Cover.*—The cylinder cover is cast with the water-jacket, and is arranged for taking the valve seatings of the air, fuel, and exhaust valves. There are through holes in the cover to take the long studs fixed in the top of the jacket.

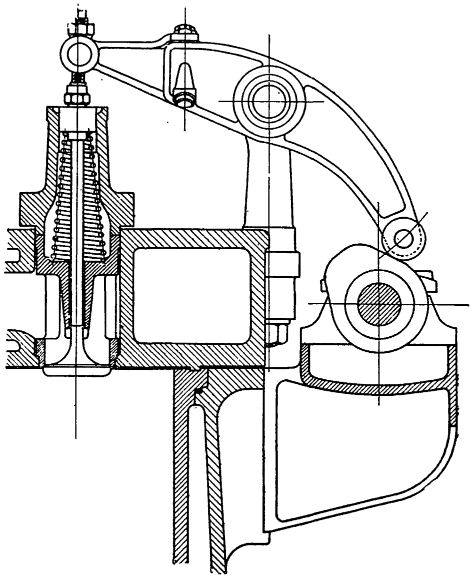

Fig. 20.

Fig. 19 shows a form of construction recommended by N. Brosne for cylinders in order to minimise the effect of the exceptional stresses due to possible explosion (instead of combustion), which may cause pressures of from 100 to 150 atmospheres in a cylinder. The cylinder head consists of a flat plate stiffened by radial and circumferential ribs arranged so that the seatings of the various valves can be placed between them. The head is closed over with a light steel cover, thus forming a space for the water circulation. There is a stiff ring of hollow section placed around the top of the cylinder and carrying the studs for bolting on the cylinder cover. This ring is connected to the framework by long steel bolts which, by their elasticity, take the shock of any exceptional explosion, and at all times relieve the cylinder walls of

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tensional stress, a matter of importance in two-stroke engines having exhaust openings through the cylinder walls at the bottom of the stroke when these walls carry the stresses.

12. *Two-to-one Shaft.*—The two-to-one shaft, or cam shaft, which is, in most engines, fitted in bearings carried on brackets, either bolted or cast with the jackets, approximately at the level of the top of the cylinder, is driven by helical gear from the crank shaft by the intermediary of the vertical shaft, the gearing being such as to reduce the speed in the proportion of two to one, so as to give a proper sequence for the four-stroke cycle. In some cases the cams are ground to the proper shape after being keyed on the shaft; other makers grind the cams to a "former," and thus obtain satisfactory results. In some of the larger engines the two-to-one shaft is run in an oil bath. In the American type of engine the cam shaft is placed inside the engine, as shown in Fig. 16. In the marine Maschinenfabrik Augsburg-Nürnberg engine the cam shaft is placed on the top of the engine, but in this case it is a two-stroke engine, and the cam shaft runs at the same speed as the crank shaft.

13. *Levers for Actuating the Valves.*—Ordinary levers of the first order are used; they have to be very stiff, as the forces at work are considerable, and there must be no perceptible deflection, or else a true opening in the valve would not be obtained. At the cam shaft end there is a roller, and at the valve end a rocking pin with a round-end bearing in a cup on the top of the valve spindle. These levers are made of cast-iron or malleable cast-iron or of steel. In many designs a hinge is arranged so as to

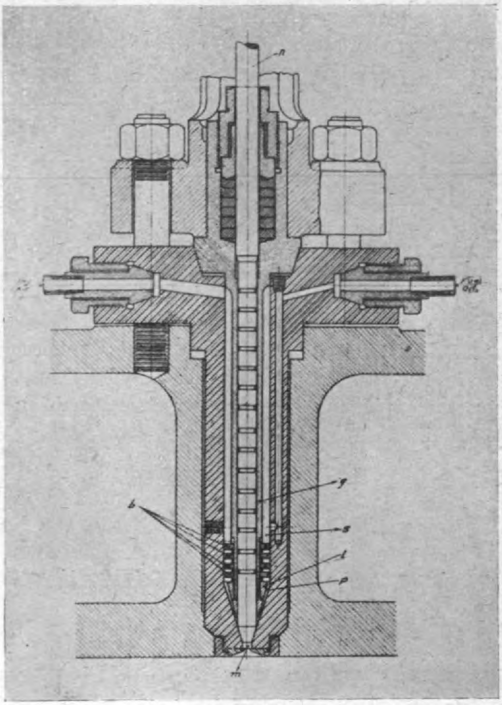

FIG. 21.

throw back the lever when it is desired to lift the valve; this is an important detail for overhauling, and is illustrated in Fig. 20.

14. *Special Lever for Starting.*—This lever works the air valve, which is fixed generally to only one cylinder. Whilst the engine is running it is out of action; for starting the engine its roller is brought into contact with a special cam, by means of a lever, and is thrown out of action again so soon as the engine begins to work on oil.

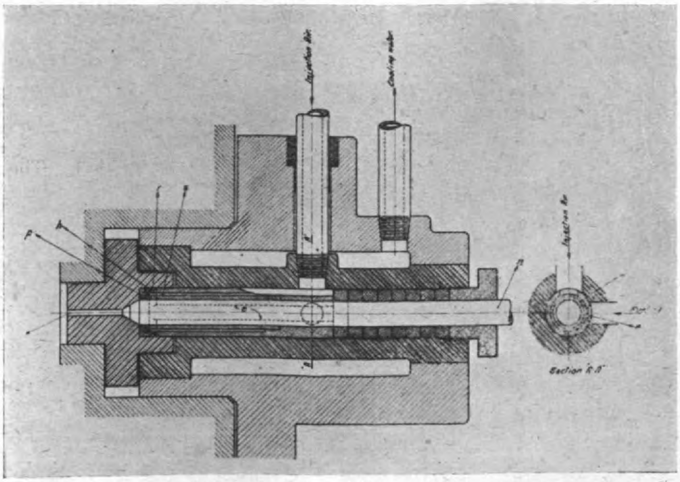

FIG. 22.

15. *Fuel Valve.*—The details of these valves vary, but in all of them arrangements are adopted to break up or pulverise the oil by violently blowing it against surfaces placed opposite to small holes; thus, as shown in Fig. 21, a series of discs having numerous holes are slung on to a central stem, the holes are staggered so that those in one disc are opposite the spaces in the holes of the next disc. At the bottom of the row of

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discs there is a grooved conical casting fitted into a cone through which the pulverised oil has to rush, and thence through a small hole at the bottom of the valve casing placed on a level with the cylinder top, and which is closed at other times by a needle valve. The lift of the needle valve is only about $\frac{1}{500}$ in.: great care is therefore necessary in fitting the levers actuating the fuel valve.

The fuel valve of the American Diesel engine is shown in Fig. 22, and it is placed horizontally. As the injection valve opens, air and oil, being divided into small streams by a circle of holes, are forced into the injection nozzle, where these streams impinge upon each other, thus atomising the fuel.

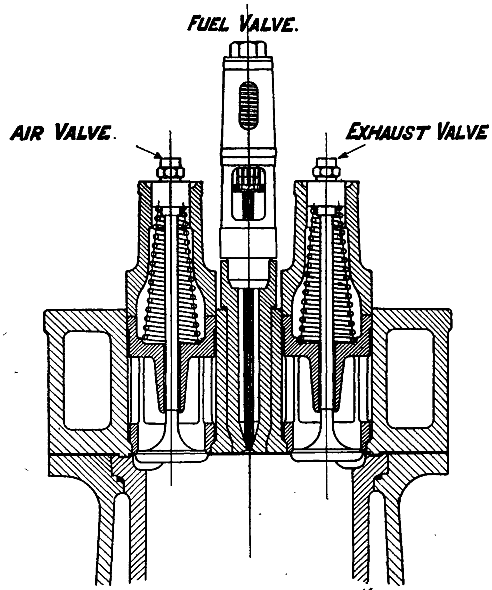

FIG. 23.

16. *Exhaust Valve.*—The exhaust valve is an ordinary mushroom valve, opening into the cylinder and held against its seat by a spring, as shown in Fig. 23, and opened by the exhaust lever at the proper point of the stroke, viz., at about 75 per cent. This valve is allowed to close at about 1 per cent. after the dead centre.

17. *Air Suction Valve.*—This is substantially the same as the exhaust valve (see Fig. 23). It opens 4 per cent. before the upper dead centre, and closes 2 per cent. from the bottom dead centre. Both the exhaust and air valves have their own seating, which is secured into the cylinder cover. This permits of harder cast-iron being used for the valve seatings, and assists overhauling and cleaning of the valves, because the valve and its seating can be bodily removed and replaced by spares. The valves open inwards into the cylinders, and are held on their seats by springs; as already stated, they are opened by means of rocking levers.

18. *Air-compressor.*—The air-compressor has to be capable of compressing air up to 1,000 lbs. per square inch, and must therefore be at least of the two-stage variety; many makers, however, such as Carels and Sulzers, adopt a three-stage compressor. Between the stages the air is cooled. The compressor is driven from the end of the crank shaft by a crank; usually it is of the reciprocating type, either vertical or horizontal, and in many cases the Reavell type of compressor is used, as in the Willans-Diesel engines. It is a vital part of the engine, and is probably one of those most likely to give trouble.

19. *Compressed - air Vessels.* — There are generally three of these vessels, or storage bottles; two to act as reservoirs for starting the engine, and a smaller one acting as an air vessel on the compressor to keep the pressure steady. They should be placed as close as possible to the engine, and are connected thereto by copper pipes. There is a gauge to show the pressure of air being delivered to the engine, which varies from about 950 lbs. per square inch for full load to 750 lbs. per square inch for quarter load. If, however, the load is varying continually the pressure must be maintained for the maximum load. The object of reducing the pressure is as follows—a definite air supply is required for burning the oil; this air is partially supplied by the air compressed in the cylinder and partly by that injected to pulverise the oil. At light loads less air is needed than at heavy loads, and, as the air compressed in the cylinder is constant in amount, that introduced by injection must be reduced, which is effected by reducing the pressure. The two starting vessels are connected to one of the engine cylinders, and the connection is made by a special lever and cam as already described, and the compressed air is admitted at each stroke until firing takes place.

Water collects in the storage bottles, and therefore drainage should be provided. The air supply is more than three times that theoretically required, and the supply is the same whether the engine is running fast or slow; a point which is of interest only for marine engines.

20. *Fuel Pump.*—The designs shown in Fig. 24 consist of an ordinary plunger pump worked by an eccentric off the two-to-one shaft. On the plunger lifting, the foot valve opens and oil is sucked in; on the return stroke the foot valve is held open by the governor until just sufficient oil remains to deal with the load then

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on the engine. This quantity of oil is then forced through the fuel valve. Makers disagree as to whether each cylinder should have its own fuel pump, or whether one larger fuel pump should be supplied for all the cylinders. In the former case, the casing of the pump contains a plunger for each cylinder, each with its own delivery; in the other case the oil is delivered into a chamber, from which copper pipes lead to the fuel valve of each cylinder, with an adjusting valve, so that each cylinder will get the same amount of oil.

21. *Fuel Tank.*—A small tank is provided with sufficient head for the oil to flow by gravity to the fuel pump. The casing should be warmed to make the oil more fluid, and this can be done by means of the exhaust. The oil is pumped from barrels, or from a storage tank, into the fuel tank by means of a hand pump.

22. *Governor.*—The usual centrifugal loaded type of governor is used, driven from the vertical shaft already referred to, and it acts on the foot valve of the fuel pump. There is generally an arrangement, actuated by a small hand-wheel working on a spring, as shown in Fig. 24, for altering the setting of the governor, by means of which the speed of the engine can be varied from 5 to 10 per cent. whilst the engine is running.

23. *Exhaust Pipe.*—Heavy cast-iron breeches pieces are taken from each cylinder exhaust and connected into one pipe; these are led generally downwards to a large silencing vessel. The pipe then rises again, and can be fitted at the top with any ordinary baffle type of silencer.

The ordinary slow-speed Diesel engine weighs from 500 lbs. to 600 lbs. per B.H.P., as against 100 lbs. per B.H.P. for a steam engine of the same number of cylinders, of the same power, and running at the same speed. In the case of the steam engine, however, the weight of the boiler and accessories, such as condensers, feed pumps, air pumps, etc., must be added, and this weight is approximately 250 lbs. per B.H.P., or a total of 350 lbs. per B.H.P.

By increasing the speed and lightening the scantlings, as is done with the engines used in torpedo boats and submarines, the weight of the Diesel engine has been reduced to about 50 lbs. per B.H.P., or even less.

The above description refers specially to vertical engines, but comparatively recently the Maschinenfabrik Augsburg-Nürnberg Co. have placed on the market a horizontal Diesel engine. According to Dr. Diesel, this, at first, was merely a vertical engine placed on its side; the more recent examples, however, are substantially the same as the horizontal gas engines of the well-known make of the Maschinenfabrik Augsburg-Nürnberg Co., and according to these makers the horizontal engine really becomes of advantage after about 500 B.H.P. The main reasons for preference are based on the facilities for overhauling, and there is the further advantage that cylinders can be readily placed in tandem. The design of the tandem double-acting Diesel oil engine is almost indistinguishable from that of their horizontal double-acting gas engine; the exhaust valve is the same, the air gas valve is replaced by an air valve, and the sparking plugs by the fuel valve. In the

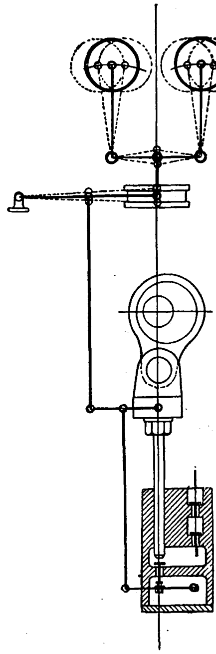

Fig. 24.

case of this horizontal Diesel engine the valves are actuated by cams, whereas, in the case of the gas engine, eccentrics are used in combination with variable fulcrum levers. This difference in valve driving is, however, to a great extent, a matter of taste.

For large engines the pistons have to be cooled, and if the engine is vertical any leakage of cooling water—which somewhat readily occurs—will fall into the crank chamber and will interfere with the lubricating oil. For this reason, it has been found necessary to cool the pistons of vertical engines by means of oil, as is done by Messrs. Sulzer. In the case of the horizontal engine, the cooling water cannot mix

up with the lubricating oil, and there is no difficulty therefore in water-cooling the pistons in exactly the same way as is done with horizontal gas engines.

The details of construction just described have special reference to the four-stroke engine; many of them, however, apply also to the two-stroke engine without alteration, such as the fuel valve and the air-compressor, the framing, crank shaft and connecting-rod. Others, such as the cam shaft and cylinders, are modified, and in order to scavenge the exhaust and introduce pure air into the cylinder at the bottom of the stroke, as already mentioned, an air blower or compressor, capable of giving a pressure of from 4 lbs. to 8 lbs. per square inch, has to be provided in addition. As regards removal of the exhaust, two systems are adopted. In one of these, as adopted for smaller engines by Messrs. Sulzer and by Messrs. Carels, scavenging valves are placed in the cylinder cover, which are similar in construction to the exhaust valves. In the larger engines and in the marine engines, however, the scavenging valves are placed at the bottom of the cylinder; they are also placed in the air pipe, and then are made as piston valves.

In the other arrangement adopted, for example, by the Maschinenfabrik Augsburg-Nürnberg Co., ports are cut in the cylinder which are uncovered by the piston at the bottom of the stroke. The air enters the cylinder by the ports on one side, and the exhaust is expelled at the other side of the cylinder, as is done in many two-stroke petrol engines—for example, the Day engine. Figs. 25 and 26 show the two arrangements above described.

The air blast is also obtained in two different ways, (1) by a separate blower, and (2) by enlarging the piston at the bottom to form an air-compressing cylinder placed under the combustion cylinders. These arrangements are illustrated in Figs. 40 and 26 respectively. (At the lecture Fig. 26 was illustrated by means of a working model lent by Messrs. Babcock and Willcox, Ltd.) Messrs. Carels use a double-acting pump driven by levers off the cross-head, following the marine practice of driving the air pump. Messrs. Sulzer use an air-compressor driven by an eccentric from the crank shaft. Another arrangement is to have separate vertical compressing cylinders driven direct by the crank shaft, and in the marine Maschinenfabrik Augsburg Nürnberg Co. engines, for the two-stroke single-acting engine a large trunk piston arrangement is used, while for the two-stroke double-acting engine they use a separate blower.

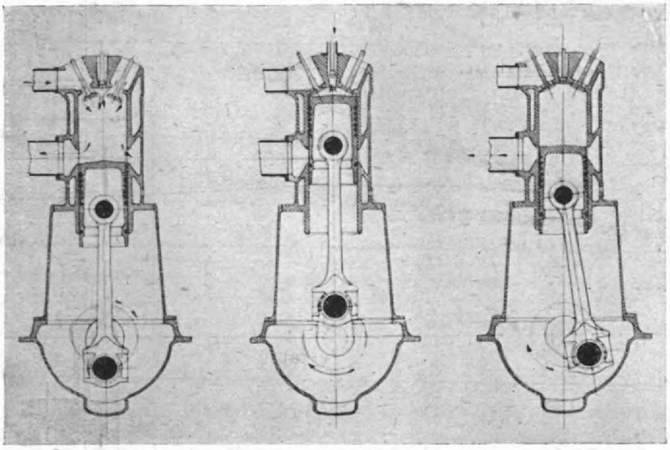

FIG. 25.

The scantlings of the two-stroke engine are substantially the same as those of the four-stroke engine of the same cylinder diameter, but it must be remembered that nearly double the power is obtained. The turning effort is better, as will be obvious from Fig. 14, and therefore a smaller fly-wheel can be used to obtain the same degree of regularity; the fuel consumption per B.H.P. is, however, somewhat higher owing to the extra work required for the air scavenging, and the stroke of the engine has to be made about 10 per cent. longer, to allow for the idle portion of the travel while covering or uncovering the lower exhaust ports. The initial cost is stated by Dr. Diesel to be about 20 per cent. less than that of the four-stroke cycle.

Four cubic feet of free air compressed to

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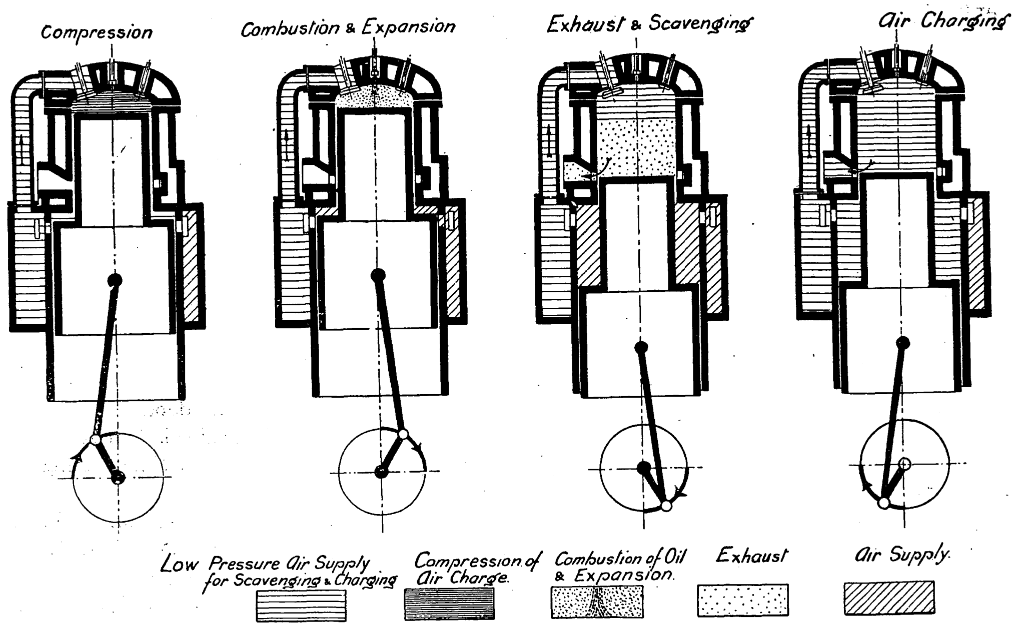

DIAGRAM DESCRIPTIVE OF WORKING TWO-CYCLE ENGINE.

FIG. 26.

from 4lbs. to 8lbs. per square inch is an ample allowance per B.H.P. per minute. Thus, in the case of two 5,000 B.H.P. engines, 40,000 cubic feet of free air would be required to be compressed per minute to about 5 lbs., and this would probably be most effectively done by means of a turbo-blower.

Another estimate is that one hundred cubic feet of air at 2½ lbs. per square inch are required per second for a 2,500 I.H.P. engine, which is equivalent to 2·8 cubic feet of free air per B.H.P. per minute. The volume swept by the scavenging air pump should be considerably greater than that swept by the engine piston, say, 1·8 times.

For marine work it is desirable to have two scavenging pumps; one as a stand-by.

Marine Diesel Engine.

Up to the present single-acting engines have been considered; but either the four-stroke or the two-stroke type can be arranged to work double-acting. In this case the ordinary box piston has to be used, together with a piston rod and its gland. The piston rod has to be of large diameter owing to the stresses to be resisted, and, owing to the high temperatures to which they are exposed, considerable difficulties have arisen with the piston glands.

For marine work a special type of Diesel engine has been developed, because, in the first place, a reversing engine is needed, and, secondly, space and weight are of extreme importance. This last requirement has, of course, a greater importance in the case of destroyers, submarines, and such like, than for tramp steamers. Thirdly, fly-wheels are objectionable, and ready starting and stopping are essential.

Dr. Diesel says: "It can now be stated with certainty that the marine engine of the future is to be of the double-acting two-stroke cycle type."

In a recent design of the Maschinenfabrik Augsburg-Nürnberg Co. marine engine of the single-acting type, a piston rod without gland has been connected to a cross-head working on the ordinary guides as in a marine engine. The piston rod is not rigidly fixed to the piston, but is connected thereto by means of a pin. This gives freedom to the piston and prevents any cross stresses.

The reversing of marine engines was originally effected either by means of clutches or else electrically. Later, arrangements were adopted for altering the timing of the valves, but in the four-stroke cycle the solution is somewhat complicated; for example, in the "Selandia" the two-to-one shaft is lifted bodily and displaced longitudinally so as to bring another set of cams into operation, then on stopping and restarting the engine runs in the opposite direction.

With the two-stroke cycle the solution is

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extremely simple, because a shift of 30° is sufficient to alter the lead of the valve from the "ahead" to the "astern" position. This shift is effected in the Maschinenfabrik Augsburg-Nürnberg Co. engine by having a coupling on the vertical shaft with two stops 30° apart; the coupling comes against one stop for the ahead position, and to go astern there is lost motion to the extent of 30° to come up to the other stop. In the Carels engine the vertical driving shaft has spiral wheels, which are revolved by the

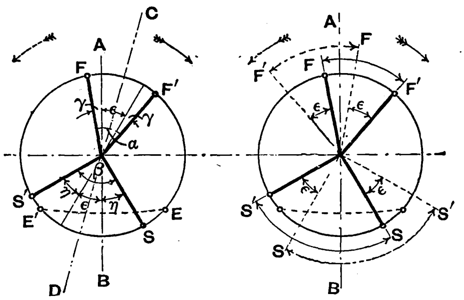

Fig. 27.

starting gear to give the necessary shift o 30°. The reason why a shift of 30° will reverse a two-stroke engine will best be seen by the valve diagram shown in Fig. 27.* On the left-hand diagram, F shows the point of fuel admission, γ being the angle of advance. F' is the point at which the fuel valve closes. S is the point at which the exhaust opens with a lead angle of η, and S' is the point of closing the exhaust. It will be seen that the angle ϵ is equal to the angle between F and F', less twice the angle of advance, and is also equal to the angle between S and S', less twice the angle of lead. Hence, if the timing of all the valves is shifted by the angle ϵ, as indicated by the dotted lines in the right-hand diagram, the opening and closing of the valves will be correctly adjusted for reversing. This angle, ϵ, is about 30°, and the shift is effected as above described.

As regards the general design of marine Diesel engines, according to Mr. Milton only the cylinders should be "Diesel," and the motion and framework should follow exactly present marine practice.

Number of Cylinders.

The number of cylinders to be employed is a somewhat vexed question, and the tendency is to use a great many, and for two reasons—First, unless water-cooled or oil-cooled, 24 ins. seems to be the largest cylinder possible, and from such a cylinder at 200 revolutions per minute the B.H.P. obtainable is 400 on the two-stroke cycle. When the piston is either water- or oil-cooled, much larger cylinders can be employed, and it would appear that 2,000 h.p. per cylinder is then obtainable. Experiments have been made with these large cylinders by the Maschinenfabrik Augsburg-Nürnberg Co., and by Messrs. Sulzer, and, so far, have been satisafctory; but no doubt some time must yet elapse before it can be said with certainty that the present arrangements are really practically satisfactory. The second reason is that many cylinders are needed to obtain a uniform turning moment, depending again, however, on whether the engine is four-stroke or two-stroke, and whether it is single-acting or double-acting.

For land work, so far, moderate sizes are being used and large fly-wheels are not objectionable, and are in some cases necessary to cope with the external changes of load. Sometimes the rotor of a dynamo supplies a large portion of the fly-wheel effect. Four lines appears to be the maximum used; three lines are very common, and for smaller sets two lines and even one are suitable.

For marine engines, however, fly-wheels are objectionable for manœuvring and reversing reasons, and as a rule the engines are of larger power, and hence six lines, and even eight lines are common.

Except for horizontal engines tandem cylinders are not used.

(*To be continued.*)

AN ARTESIAN TUBE WELL.

The authorities of the Institution of Civil Engineers having come to the decision of providing an independent supply of pure water from an artesian tube well to meet the requirements of their new building in Great George Street, Westminster, boring operations were commenced from the sub-basement floor of the building, 19 ft. below street level.

Beginning with 10-in. outer protecting tubes reaching through the gravel well into the solid clay so as effectually to seal out all sub-soil water, tubes of a smaller size were next employed telescopically for the temporary lining of the intervening strata from the clay to the chalk to enable the permanent tier of 6-in. tubes to be carried to the chalk, into which they were tightly driven 18 ft., thus effectually sealing out the very fine Thanet sand, which otherwise might interfere with the proper working of the pump.

This accomplished, the borehole was continued unlined a further 210 ft., thus making a penetration

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of 228 ft. into the upper chalk formation, or a total depth of 450 ft. from basement floor.

When the chalk springs were struck the water rose to within 174 ft. of the basement, *i.e.*, to 176 ft. below ordnance datum. An exhaustive pumping trial on the completion of the boring demonstrated that the well was capable of yielding quite double the quantity required for the needs of the establishment, and it may be mentioned that the whole work was completed in the very short space of seven weeks.

A feature of interest is the fact that the water, though drawn directly from the fissures in the chalk, is yet very soft, this being accounted for by the chalk being hydrostatically in communication with the overlying Thanet sand bed, the water from which is of an alkaline nature, whereas in other districts in the London Basin where the Thanet sands are missing, chalk water is naturally of a more or less decidedly hard nature.

The thicknesses of the different formations of strata passed through may roughly be given as follows: alluvium, 17 ft. 6 ins.; tertiaries (consisting of London clay, 118 ft. 6 ins.; Woolwich and Reading beds, 58 ft.; Thanet sand, 28 ft.); and upper chalk, 228 ft.

THE MUSEUM, THE SCHOOL, AND NATURE-STUDY TEACHING.*

Museum officials have at last realised the necessity of studying the needs of the visitors to the collections under their charge. The search for knowledge through the impetus given by free education has made museums, along with similar institutions, centres for research. Hence the museum must have its ideal, and a definite plan for carrying it out has to be evolved. Into this scheme educational types of exhibits must necessarily come. The public has to be divided into classes, and exhibits must be suited to each. Hence the material, since it is specialised, is much more valuable than any other former methods could devise. One section, the students' section, is increasingly useful, and therefore requires special development.

Moreover, it is obvious that the museum is merely part of a general scheme of education that each child in its educational progress may—or should—make use of, in the same way as an art or technical school, free library, and so on. Hitherto, however, this fact has been lost sight of, and it is to emphasise the importance and to demonstrate the practical value of the museum in the education of the young that this summary is devoted. A parallel feature of modern education has been the rise of Nature-study. Evolved from the old object-lessons, it has now emerged as an experimental subject into the clear light of advanced methods. It is in fact a method, teaching observation, inculcating logic and reasoning power—and no age was more in need of this—instilling a desire to learn in the young mind, and communicating enthusiasm.

This being so, it is a subject to encourage. The value of Nature-study lies in its association with things, and the necessity of handling them. But it is the museum, above all, which deals primarily with concrete examples, where a man can illustrate ideas by specimens, which he may even touch. Indeed, for the student a museum is the only place in the district where—in Natural Science at any rate—a knowledge of types of different things can be seen and studied. Hence its importance for use by schools.

Within the last ten years museums have been much visited by schools. But it is unfortunate that the true inter-connection between the two has been ignored, and the museum has not been used to advantage. There has been no co-operation. Teachers have used museums in their way without inquiry. Recently, however, realising the necessity of ensuring the effective use of Leicester Museum, lectures have been delivered to the elementary school teachers upon the material in the museum, and upon the general principles of scientific subjects, with considerable success. The extension of this system is advocated.

* Abstract of paper read before the Educational Science Section of the British Association by A. R. Horwood.

EXPERIMENTS ON "SUCTION" OR INTERACTION BETWEEN PASSING VESSELS.*

In view of the general lack of experimental data as to the magnitude of the mutual forces involved in the cases of interaction between two vessels moving in parallel paths in close proximity, and as to their effective range of action, the authors decided to carry out a series of experiments to investigate these points on boats of sufficiently large size to enable the results to be applied with some confidence to seagoing vessels. The vessels used were the steam-yacht "Princess Louise" and a motor-boat. Each is propelled by a single screw, and their details are given in the table below:—

* Abstract of paper read before the Engineering Section of the British Association by Professor A. H. Gibson, D.Sc., and J. Haunay Thompson, M.Sc., M.Inst.C.E.

Vessel.	Length between perpendiculars.	Beam.	Draught.	Displacement.	Rudder Area.
	Ft. In.	Ft. In.			
"Princess Louise"	88 6	13 0	6 ft. forward 7 ft. aft	—	—
Motor-boat	29 6	6 9	2 ft. 3 in.		100 sq. in.

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Two sets of experiments were carried out. In the first the helm of the motor-boat was lashed amidships, with the vessels on parallel paths, and its behaviour was noted when at different lateral distances, and when the boats were moving at different absolute and relative speeds. Its position relative to the "Princess Louise" was determined by angular measurements taken from the latter vessel at intervals of fifteen seconds. Pressures at a series of corresponding points on the two sides of the motor-boat were measured at the same instants, with a view to determining the lateral forces involved.

The second series of experiments was devoted to a determination of the helm angle necessary to maintain the course of the motor-boat when in different positions relative to the larger vessel.

Owing to possible collision risks the maximum speed was limited to six knots, which, in the case of the "Princess Louise," corresponds to eighteen knots in a vessel of the size of the "Olympic." The results show that with both vessels moving at about this speed with helms amidships the smaller vessel is drawn into collision from any lateral distance less than a hundred feet (three and a half lengths of the smaller vessel). The precise behaviour depends largely on the relative and absolute speeds of the vessels and on their initial distance apart and initial relative position. These points were discussed in the paper, as was the question of the helm angle required to prevent collision.

The authors are of opinion that the experiments prove conclusively that the forces involved during interaction are much greater than has been generally realised hitherto, while they have been particularly impressed by the rapidity with which collision usually follows the first sign of any interaction.

LIFE-BOATS ON OCEAN-GOING SHIPS AND THEIR MANIPULATION.*

The urgent necessity for revising present regulations referring to life-saving appliances at sea has recently been brought home with terrible force to the public mind. Anticipating the ultimate results of the international deliberations at present in progress, the United States Government have already stipulated that every ocean-going passenger steamer must provide sufficient boat accommodation for every soul on board.

To the lay mind such a rule must appear perfectly reasonable, seeing that no objection on the ground of expense can be permissible in a matter of this nature. But it must be borne in mind that the mere fact of carrying a full complement of life-boats implies no guarantee of safety. Unless the boats can be readily manned and launched with a fair degree of certainty, they only constitute so much lumber usually carried about. And it may be categorically stated that there are a large number of ships now in commission on which boats cannot be efficiently arranged to accommodate everybody on board.

Considerable improvement may, however, be effected in the conditions hitherto prevailing, and it may safely be said that all the better-class passenger-carrying companies are giving the matter most careful attention. The general adoption of wireless communication between ships, and also the success of anti-rolling tanks, have enormously augmented the value of the life-boats in cases of emergency. The last-mentioned invention practically removes the risk of boats getting crushed against the side of the ship when lowered in bad weather, and wireless telegraphy has reduced the question to one of providing means for transferring people from one ship to another in case of disaster. Strong seaworthy boats, with the largest obtainable displacement for a given length, will now best meet the requirements, a high degree of navigability being of much less importance than formerly. Detachable deck-houses, life-rafts, and the like, are, in the author's opinion, of very limited value.

On account of the continually increasing height of modern ships, the old question of substituting wire ropes for the usual manila falls has come up again with renewed force. The problem is, however, one of considerable difficulty in view of the ever-varying conditions under which the launching of the boats may have to be carried out.

The first ship to obtain a really efficient davit installation of this nature is the steamship "Imperator," of the Hamburg-Amerika Line, on which the majority of the boats stand some seventy feet above the water-line. The launching of boats on this vessel may be effected in from forty to fifty seconds, and a special adjusting gear permits of the boat descending at any required angle—a point of the greatest importance. The hoisting is done by means of an electrically-driven "fore-and-aft" transmission shaft provided with "friction-drivers," each boat being handled quite independently of the others. The largest life-boats are capable of accommodating seventy-six people, and weigh, fully loaded, approximately eight tons each.

* Abstract of paper read before the Engineering Section of the British Association by Axel Welin.

EMPIRE NOTES.

Colonial Representative Government.—The rapid and solid growth of Canada was brought home to all who were able to attend the recent celebrations at Halifax, Nova Scotia, when the beginnings of representative government were commemorated by the inauguration, by H.R.H. the Duke of Connaught, of a national memorial tower. When John Cabot discovered Cape Breton, neither he nor his contemporaries had any idea of what that discovery meant, any more than we to-day can foresee the ultimate magnitude of the Canadian Dominion. This year is the 154th anniversary of the opening of the Nova Scotian Assembly, and it

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is claimed that this is the earliest legislative body to be set up in the present Colonial Empire. This claim, however, may be contested by Bermuda and Barbadoes. Mr. Algernon E. Aspinall, in writing to the *Times*, points out that Bermuda was granted representative government in 1620, and that Barbadoes had representative institutions granted to her by Royal Charter in 1627, and confirmed by the Commonwealth in 1652. The dedication of the memorial tower in Halifax, and the event commemorated are of outstanding importance in the history of our Imperial race. When we look back 154 years to October 2nd, 1758, and at the nineteen representatives elected by the people of Nova Scotia, who formed the first legislature, we realise that that assembly, although perhaps not marking the beginning of the policy of self-government within our Empire, is yet one of the first great steps in that direction. The advisability of noting that event for the present and future generations is apparent. Since the germ of representative government was planted in Halifax, the British Empire has taken root in Australia, New Zealand, India, and the Cape. Nine provincial and one federal legislatures have been developed in the Dominion Government alone, and some thirty or thirty-five others throughout the Empire. The humble gathering of the nineteen representatives of the early settlers of Nova Scotia may lack the brilliance and the glory of the battle of Plassy of the previous year, or the Plains of Abraham of the following year, but in it is assuredly the foundation-stone of the Empire's greatness and development—the principle of self-government.

Motor-cars in Canada.—It is interesting to note how the well-being of Canada is shown in the common use of the motor-car, and this despite the hindrances in the way of poor roads and other obstacles to locomotion. The bulk of the cars are imported, the greater number from the United States, and a few from England. There are, however, seven or eight motor companies in Canada, two of which are native Canadian undertakings turning out a special type of car. The popularity of the car is greater in western than in eastern Canada; and this is easily explained by the contrast between the topography of these two parts—the open prairie, with its trail and small rainfall, permitting easy travel in almost every direction. Doubtless, if the tests now being made in Australia of the motor-car, which is made on very much the same principle as the stump-jump plough, and rides over rough bush roads without jolting. passengers or goods, are successful, the eastern provinces of Canada will be able to make use of motor locomotion in many districts where it is now practically impossible.

The Australian Trans-continental Railway.—The ceremony of turning the first sod of the great Australian railway which will link up east and west was recently performed by the Governor-General. With the construction of this railway, 1,073 miles in length, the federation of Australia will be completed in a manner which no common constitution or common laws could effect. One of the prime objects of the railway is to provide for more efficient defence by enabling troops to be transported quickly from east to west, should any of the ports of Western Australia be attacked. It is to be hoped that its usefulness as an adjunct to civilisation will have justified its building years before the test of defensive necessity arises, if it ever does. Although war is to be deprecated, the fear of attack will be of service to Australia if it spurs her on to develop her immigration policy, and to build such railways as those which will soon traverse the continent from east to west and north to south, thus rendering available her vast unutilised resources. Much of the railway from Port Augusta to Kalgoorlie lies in country of very low rainfall, which has hitherto been regarded as desert. But everywhere in Australia the desert has steadily shrunk before the march of knowledge and settlement. There are flourishing sheep and cattle stations now near Cooper's Creek, in Queensland, where Burke and Wills starved to death in their memorable exploring expedition fifty years ago. It is therefore permissible to hope that when the railway is built very much of the land bordering upon it will be found useful for pastoral settlement, if not for agriculture. The surveys, indeed, have already proved that this is probable. The storage of water obtained from the rainfall is possible in several places, and artesian wells will, doubtless, become the centres of flourishing oases where crops and fruit will be grown. There is also more than a probability that the building of the railway will lead to the discovery of new deposits of metals and minerals, and the building of busy towns in the wilderness. It may be several years before the railway begins to pay in the monetary sense, as eventually it is sure to do, but in the meantime it more than justifies itself by bringing west and east into closer relations, and rendering complete the federation of Australia.

Southern Rhodesia.—The report for 1911 of the Director of Agriculture for Southern Rhodesia can now be obtained, and shows the rapid strides which husbandry is making in that colony. The total area under cultivation is about one million acres, the increase in all European crops since last census being very considerable. Thus maize shows a 758 per cent. extension, tobacco has risen from 147,000 lbs. in 1904 to 606,000 in 1911, and coffee from 42 lbs. to 14,000 lbs. The report speaks of a steady rise in the leading exports—hides, skins, tobacco, maize, and onions—and of substantial purchase of agricultural machinery. The ranching industry has also made satisfactory progress, the Leibig Company alone having introduced over 1,000 head of cattle. Similar ventures on a smaller scale are coming into being in various parts of the country. The culture of tobacco in Rhodesia, although already a large and flourishing industry,

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is really only in its infancy. It is the rich, low-lying portions of Rhodesia which, as railway communication is opened up with the markets, will furnish double, and even treble, crops with a minimum of trouble. Down on the low veldt, in the great sandstone belts that traverse the country from Wankies to Lomagundi, are valleys where tobacco can be grown under ideal conditions; and eventually, as settlement proceeds, the low veldt will be tapped by one or more railways. When that occurs the industry should make giant strides.

Egyptian Oil.—There is much interesting reading in the account of the exploration work that has been done in the Egyptian oilfields, and which is being pushed forward with energy. The one area which appears to have proved to be productive on a commercial scale is that comprising the peninsula of Jemsa, the oil yield there being mostly of good quality and the barrellage satisfactory. Evidence of oil is also to be found on some of the islands as well as on the mainland. Prospecting is being carried still further afield, and it is probable that at an early date sinking will be undertaken in other areas than those already being carefully explored. There has been active development of other mineral products quite recently. Two companies are prospecting large occurrences of manganese ores on the western side of the Sinai Peninsula to the north of Tor, and a large deposit of phosphate ore is now being worked on the western coast of the Red Sea.

NOTES ON BOOKS.

Colour in the Home. With Notes on Architecture, Sculpture, Painting, and upon Decoration and Good Taste. By Edward J. Duveen. London: George Allen & Co., Ltd. £2 2*s.* net

"Magnifica in Frontispicio, Ridicula in Penetrali," is found, on reading through this sumptuous volume, in no way to apply to it, notwithstanding that the disproportion between its size, and whole "format," might well suggest to an incautious critic that it was but another of those Buncombe books of "three-colours printed" illustrations, all binding and pulpy paper, wherewith—since George Cruikshank, and Richard Doyle, and Randolph Caldecott, and Kate Greenaway have ceased to live for us—our publishers have, during the past three or four years, been piling up their counters throughout Christmas tide. This volume is 12½ inches in height, and 10½ in breadth, and 1¾ in thickness; and although it contains but seventy-five pages of actual text, it weighs 4 lbs. 11 ozs.; this weight including that of forty-four or forty-five illustrations, with their added "label-sheets," and of course the binding; which, for all its chaste harmony of French grey and gold, is not strongly "forwarded." The illustrations in not a single instance justify paper of such imposing dimensions, while to trickle a text of about 300 words through "meadows of margin" 2¼ inches and 2½ inches, top and bottom, respectively, and 2¼ inches on the outer side, and 1¼ on the inner, is indeed "wasteful and ridiculous excess" in the art and craft of "book-making." I am the more extreme to mark these details, not so much because of the growing tendency observable of recent years to subordinate the art to the craft of costly publications, as because the bad taste of it always arouses suspicions of their good faith; than which nothing can be more damaging in the case of books dealing with the fine arts, and the applied arts, and education in art. Mr. Duveen's book should have been a crown 8vo, bound in French grey and gold, as it is, but stronger backed; and to range on the shelves with such classical monographs as Yates' "Textrinum Antiquorum," Thomas ["Anatasius"] Hope's "Household Furniture," and John Burnet's "Treatise on Painting."

But this remonstrance put aside, and turning to Mr. Duveen's personal part in the production of the volume, he may rest assured of the gratitude and praise of every cultivated reader for a most instructive and captivating essay on "Colour in the Home," based on the soundest technical, and scientific, and philosophical inductions, and expressed in the simplest terms, and illustrated with the happiest and most effective pertinence by a man of unfailing good taste in all his chromatic combinations,—painting from a Florentine palette delicate and dainty as Botticelli's own. Every paragraph, every picture throughout the essay, is set in "the quiet and still air of delightful studies," and, its unhandiness notwithstanding, it provides the right inspiration for all persons of ample means and refinement, who would have their homes made beautiful. For all the lucidity and ease of Mr. Duveen's literary style, it is evident that he has studied his subject in the writings of its greatest theoretical and practical exponents, from Plato to Goethe, and Hegel, and Schopenhauer, and from Aristotle, and Ptolemy, to Newton, and Helmholtz, and Chevreul; and, being endowed with innate good taste of his own, perfected by practice, his essay may also be unreservedly recommended as a working "Vade Mecum" to all experts in art professionally occupied in its application to the construction, furnishing, and decoration of "the stately homes" of the wiser of the wealthier classes of the United Kingdom. I repeat the qualifications,—"of the wealthier classes," and "persons of ample means," because true artistry demands that the houses of the merely comfortable middle classes, and, again, of the cruelly competitive wage-earning labouring classes, should not be, literally, tricked out with worthless and vulgarised imitations of the chairs, tables, bedsteads, and upholsteries, and other chattels, of the hereditary, and the newly enriched, or "jumped up" upper classes.

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A novel and most suggestive feature of Mr. Duveen's essay is to be found in the chromo-prints interleaved with it, in illustration of schemes of decoration for dwelling-rooms, based on the colourings of the wings of butterflies and moths. The frontispiece, entitled "A Morning Room," and, again, a print toward the end of the volume, entitled "An Elizabethan Oak-panelled Dining Room," are most fascinating examples of this, so far as I am aware, entirely original device for applying chromatic harmonies adapted from the wings of insects to the purposes of art furniture and general household decoration. There is, indeed, no problem arising out of the contemplated decoration of our dwellings, whether of proportion or colour combinations, that Mr. Duveen's monograph will not help those who consult it to solve; provided always that they themselves have an eye for just proportion, and for concordant colouring, alike in its diffusion and focal centres. What Mr. Duveen says on the mental and moral effects of colours, on pages 73, 74, I must quote in full:—"In all harmonious combinations of colours, whether of mixture or neighbourhood . . . (blue) is in colouring what the note C is in music, the natural key archeus or ruling tone. Universally agreeable to the eye, when in due relation to a composition, it may be more frequently repeated therein in its purest or unbroken state, than either of the other primaries [yellow and red]. The moral expression of effects of blue or its influence on the feelings and passions partake of its cold and shadowy relations in soothing and inclining to melancholy [cf. 'the blues'], accordingly it is rather a sedate than a gay colour, even when in its utmost brilliancy. These analogies and effects of colour are by no means to be disregarded; they have a stronger influence on the mind than they are generally credited with, and it is by attention to them that colour conduces to sentiment and expression in painting. Even when the symbolical uses of colour are merely fanciful or conventional, they are not to be neglected, since by association and common consent they acquire arbitrary significance. With white and all colours that approach it, we associate gladness and gaiety, while sorrow and pain, and mystery, immediately arise in the imagination with blacks and solemn browns. These feelings are inherent and in the nature of things, and just knowledge of the relations of colours and their effects upon the passions and feelings seem hardly less essential to the poet than to the painter; hence he often employs their ideas and terms with happy effect."

This is sound in science, and philosophy, and tradition, and technique, and could not be more soberly and lucidly put; and the truth of it all should ever be present to the mind of the architect, the decorator, and the house furnisher, and particularly of the upholsterer. Mr. Duveen has also some very pertinent observations on the dressing of women; but this is not so vital a matter, for, in fact, so long as a woman is either ladylike, or good-hearted, or merely good-looking, whatever her "wear," it will become herself—even the current execrable fashions of women's "wear," that violate every canon of art, and, in the case of vulgar women, of propriety; and therefore I will refer readers of our *Journal*, interested in this entirely æsthetical problem, to Mr. Duveen's monograph itself. He will fully repay them as a guide in colour; for form, they should go to the afore named Thomas Hope, his "Costume of the Ancients," and "Designs of Modern Costumes," both written over a hundred years ago now: but—"What is best is ever fresht."

GEORGE BIRDWOOD.

THE POSITION OF LANDSCAPE IN ART. By "Cosmos." London: George Allen & Co., Ltd. 3*s*. 6*d*. net.

Whether they agree or not with the principles and conclusions laid down by "Cosmos," readers of this volume will find it both readable and stimulating. It has apparently been provoked, in part at least, by recent developments in the world of art. "Cosmos" has no patience with impressionists, post-impressionists, cubists, futurists, *et hoc genus omne;* he has only a lukewarm appreciation even of Whistler; but on the other hand he has a very great and well-reasoned admiration for those who are generally recognised as the great masters of painting. With this part of his thesis probably the large majority of his readers will be in cordial agreement; but when he comes to consider the position of landscape in art, no doubt he will find a good many disposed to question his views. Landscape painting, he thinks, has been placed on a pedestal far higher than its merits deserve; and he blames Ruskin for having brought about this state of things, with its deplorable consequences—"thousands of landscapes, good, bad, and indifferent, which form the flotsam of the art trade . . . and the unrecorded history of useless industry and wasted lives, of broken spirits and despairing hearts." There can be no doubt, of course, that we have an enormous superfluity of bad and indifferent landscapes, but would a similar superfluity of bad and indifferent figure pictures be any better? Possibly, however, the contention of "Cosmos" is that Ruskin encouraged a large number of people, who ought never have tried to hold a brush at all, to become painters of landscape, and if this is his point far be it from us to dispute it, for neither men, gods, nor the picture dealers ought to permit mediocrity in painters any more than in poets. We are, however, still disinclined to admit the comparatively lowly function which he would ascribe to landscape painting. We have known people who have drawn a more complete and satisfying pleasure from the calm beauty of Rembrandt's "Mill" than from all the sacred masterpieces which "Cosmos" would set high above it.

"Cosmos" is perhaps at his best when criticising the critics. In Chapter VII. he deals excellently with the champions of the post-impressionists, and

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reduces their premises to their logical absurdity. But it is not only post-impressionist critics who write the sort of stuff that the uninitiated can only describe as bunkum, and in one of his notes at the end of the volume, "Cosmos" quotes some gems from the pen of one who is regarded by many as a high authority. Speaking of a portrait by Rembrandt in the last Winter Exhibition of the Royal Academy, this critic writes: "Nothing could be greater or simpler. And by what magic—though we do not leave earth or the commonplaces of everyday existence—is the whole great problem of humanity, of life, thus indefinably evoked? No veil is lifted; yet the wonderment of man at the awful mystery that is his brother-man, the going out in all humility of heart and soul to heart and soul, the fusion by sheer love of one being in another—these things are suddenly realities to us." And again, of Watts's picture, "The Sisters": "There is in the picture, above all, a chord compound of music of two souls, vibrating not in unison, but in a relation subtler still, and more beautiful." Well may "Cosmos" remark that it is amazing to what length English critics sometimes go in their endeavours to find psychological meanings in pictures.

GENERAL NOTES.

Celluloid.—In view of the recent disastrous fires which have occurred in places where celluloid is stored, it is interesting to learn that the Home Secretary has appointed a committee "to inquire and report as to the precautions necessary in the use of celluloid in manufacture, and the handling and storage of celluloid and celluloid articles." The names of the members of the committee are: The Earl of Plymouth (Chairman); Professor James J. Dobbie, F.R.S., Principal Government Chemist; Captain Maurice B. Lloyd; Mr. H. M. Robinson, Deputy Chief Inspector of Factories; and Mr. Edwin O. Sachs, Chairman of the Executive of the British Fire Prevention Committee.

The "Shipbuilder."—After six years' existence as a quarterly, the *Shipbuilder* has, with the October number, been converted into a monthly journal. It will continue to be published simultaneously, as heretofore, in London and Newcastle-on-Tyne, and will be exclusively devoted to shipbuilding, ship repairing, and marine engineering.

"The International Whitaker."—Messrs. J. Whitaker & Sons, Ltd., are preparing an international edition of their almanack under the title of "The International Whitaker." The new book, which supplements but does not supersede the older "Whitaker," is to be bound in cloth and to contain about 700 pages. The armies and navies of the Great Powers, the trade of the leading mercantile nations, and the needs and possibilities of partially developed countries are receiving special attention. The volume will be published early in December at the net price of 2s.

The Java Tea Industry.—The cultivation of tea was introduced into the island of Java in 1826, and was classed among government cultures. About 1842, private planters in the island began to occupy themselves with this culture, which until then had been monopolised by the government. After the Agrarian Bill of 1870 had passed into law, the number of tea-planting companies in Java increased very rapidly. In 1878 Assam tea was transplanted to Java as supplying a product more suited to the taste, and giving a better yield. At present the cultivation of this tea has entirely supplanted that of China tea in the island. According to a report recently prepared by the Netherlands Ministry of Agriculture, the quantity of tea produced in Java in 1900 was 6,600 tons; in 1905, 11,228 tons; and in 1911, 22,800 tons. The bulk of these teas is sent to the Amsterdam and London markets. Of late years, and especially in 1911, large quantities have been also dispatched direct from Java to Australia and Russia, and smaller quantities to other countries.

Japanese Coal for Railways in Chili.—A Santiago journal states that coal from Japan is beginning to be largely used on the Chilian railways. It is found to be cheaper than that of Australia. It is hoped eventually to establish a considerable trade in return by exporting nitrates to Japan and so reduce the cost of freight, to the mutual advantage of both countries.

MEETINGS FOR THE ENSUING WEEK.

Tuesday, October 15...Sociological, at the Royal Society of Arts, John-street, Adelphi, W.C., 8.15 p.m. Professor Geddes, "Mythology and Life: an Interpretation of Olympus."

Photographic, 35, Russell-square, W.C., 8 p.m. Dr. F. Goldberg, "The Resolving Power of Photographic Plates."

Our Dumb Friends' League, Whitehall Rooms, Whitehall-place, S.W., 3 p.m. Mr. J. Buckland, "The Value of Wild-Bird Life in the Empire."

Wednesday, October 16...Microscopical, 8 p.m. Conversazione at King's College, Strand, W.C.

United Service Institution, Whitehall, S.W., 3 p.m. Captain G. S. MacIlwaine, "The Corrugated Ship."

Thursday, October 17...Child Study, 90, Buckingham Palace-road, S.W., 7.30 p.m. Dr. T. Percy Nunn, "Psychological Development of the School Subjects."

Chemical, Burlington House, W., 8.30 p.m. Sir Oliver Lodge will deliver the Becquerel Memorial Lecture.

Automobile Engineers (Birmingham Centre), University Buildings, Edmund-street, Birmingham, 8 p.m. Mr. Douglas Leechman, "The Influence of Low Production Cost on Quality."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. Francis Ward, "Fur, Fin and Feather under Water." (With cinematograph.)

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Journal of the Royal Society of Arts.

No. 3,126. VOL. LX.

FRIDAY, OCTOBER 18, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

HEAVY OIL ENGINES.

By Capt. H. Riall Sankey, R.E. (Retired), M.Inst.C.E.

Lecture III.—Delivered May 13th, 1912.

Various Types of Diesel Engines.

There are a very large number of makers of Diesel engines, especially on the Continent of Europe; but so far in this country for land purposes there are only two makers of repute, and the largest engine made by them is about 600 B.H.P. A large majority of the engines manufactured are of the vertical type, and there is a great similarity in all the designs. There is not the same variety that is to be found amongst steam engines, and the reason is twofold; the designs have emanated practically from one source, and the differences caused in steam engines by variations in steam pressure, and whether the engine is condensing or non-condensing, do not occur. The differences consist principally in the methods of driving the cam shaft and the compressor, and in details of valve levers, fuel pumps and governors, as will be seen by an examination of the slides exhibited.

Figs. 28 to 43 are reproductions of some of these slides, and the following is a complete list, together with the special points referred to:—

Experimental engine in 1897 by Messrs. Mirrlees, Watson & Yaryan.

Single-cylinder engine, with vertical compressor driven direct by the shaft, and fitted with large fly-wheel driving a dynamo through flexible coupling. (Messrs. Mirrlees, Bickerton & Day.)

Fig. 28. Similar engine driving a dynamo by means of a belt. (Maschinenfabrik Augsburg-Nürnberg Co.)

Figs. 29 and 29A. 250 B.H.P. two-line engine, A frame design, with ring lubrication. (Messrs. Sulzer Bros.)

Fig. 30. Three-line 450 B.H.P. engine, A frame design, with ring lubrication. (Messrs. Sulzer Bros.)

Three-line engine, closed crank chamber, for forced lubrication.

Fig. 31. Three-line engine driving dynamo direct, fitted with large fly-wheel, A frame with jacket in one casting. Reavell horizontal air-compressor. (Messrs. Willans & Robinson.)

Fig. 32. Two-line engine, A frame type, crank closed in with sheet steel, showing boiler for utilisation of exhaust gases; 8 to 9 per cent. of the total heat is thus recovered. (Messrs. Sulzer Bros.)

Fig. 33. Standard three-cylinder two-stroke engine with exhaust valves in the cover, showing water-cooled exhaust pipes suitable for powers from 600 to 800 B.H.P. (Messrs. Sulzer Bros.)

Fig. 34. Four-line engine driving a dynamo direct, fitted with Reavell compressor. (Messrs. Willans & Robinson.)

Fig. 35. Four-line four-stroke enclosed forced lubrication engine, with horizontal compressor. (Messrs. Sulzer Bros.)

Fig. 36. Standard four-line two-stroke engine, with exhaust belt at middle of cylinder; water-cooled exhaust pipes suitable for powers up to 1,000 I.H.P. (Messrs. Sulzer Bros.)

Fig. 37. Four-line high-speed engine with closed crank chamber for forced lubrication, directly connected to dynamo, suitable for ship work. (Messrs. Sulzer Bros.)

Non-reversing high-speed engine made suitable for ship propulsion by reversing gear. (Messrs. Mirrlees, Bickerton & Day.)

Similar engine showing arrangement of air cylinders and silencer.

120 B.H.P. engine for driving a pinnace, enclosed crank chamber, forced lubrication, friction clutch and reversing gear. Speed can

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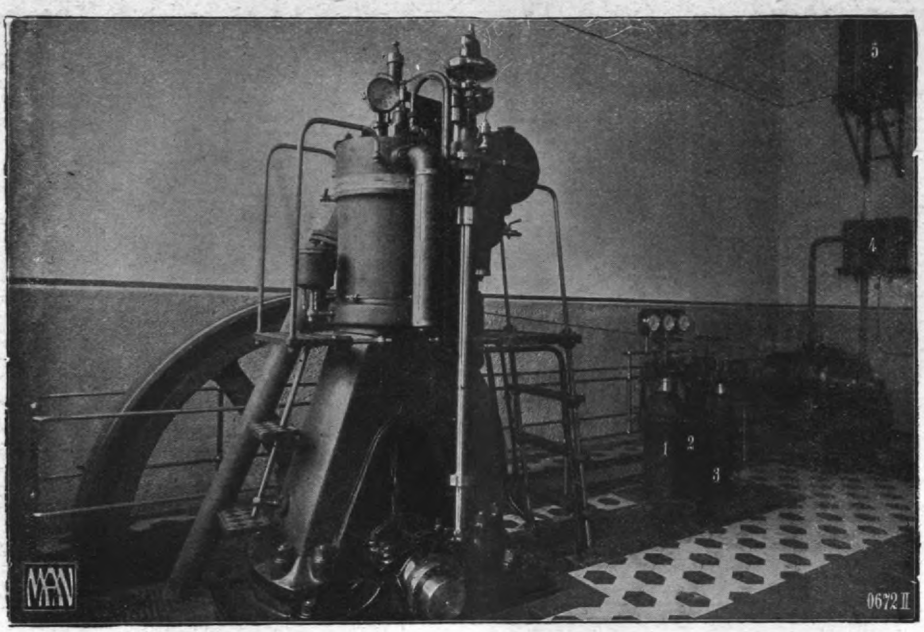

FIG. 28.

be varied over a considerable range; there is a separate compressor driven off the shaft by means of a chain. (Messrs. Mirrlees, Bickerton & Day.)

Three-line double-acting slow-speed marine engine under test. (Maschinenfabrik Augsburg-Nürnberg Co.)

Six-line single-acting two-stroke engine for marine propulsion, scavenging air being obtained by enlargement of the cylinders; two compressors for supplying fuel air blasts, single cam shaft along the tops of the cylinders showing clutch on vertical shaft with 30° play for reversing the engine, hollow connecting-rod, nickel plate for protecting central part of piston against high temperature. (Maschinenfabrik Augsburg-Nürnberg Co.)

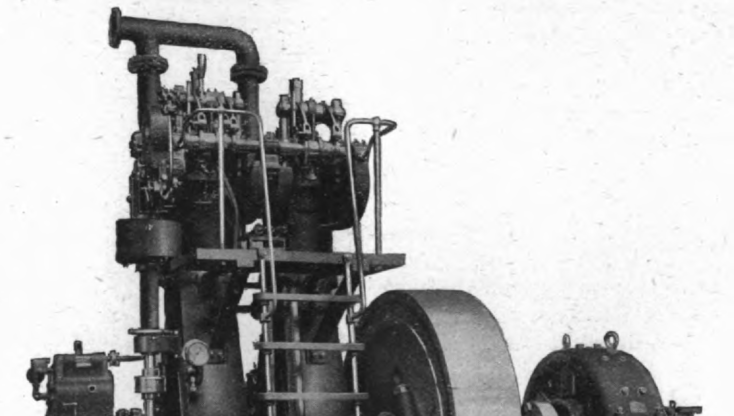

FIG. 29.

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TABLE II.

SIZES MANUFACTURED BY BURMEISTER AND WAIN, LTD.

B.H.P. One Cylinder	30	40	50	60	75	(100)	(125)	(150)	(175)	(200)	(250)
Two Cylinders . .	—	80	100	120	150	200	250	—	—	—	—
Three Cylinders . .	—	—	150	180	225	300	375	450	525	600	750
Four Cylinders . .	—	—	200	240	300	400	500	600	700	800	1000
R.P.M.	250	240	225	210	200	190	180	170	160	150	150

Fig. 38. Outside view of the above engine. (Maschinenfabrik Augsburg-Nürnberg Co.)

Fig. 39. Outside view of reversible four-line two-stroke 400 B.H.P. engine, enclosed crank chamber, with scavenging air blower driven direct by the shaft. (Messrs. Sulzer.)

Fig. 40. Longitudinal section through engine shown in Fig. 39, showing scavenging blower and two-stage air-compressor driven direct by the crank shaft.

Figs. 41 and 42. Plan and cross-section of the above engine.

Enclosed marine engine, six-line, similar to above. (Messrs. Sulzer.)

Fig. 43. Horizontal double cylinder, single-acting, two-stroke engine of 500 B.H.P., showing scavenging blower, driven direct by extension of crank shaft. (Maschinenfabrik Augsburg-Nürnberg Co.)

SIZES IN CURRENT USE.

Many makers publish lists of sizes up to 1,000 B.H.P. Table II., based on Messrs. Burmeister and Wain's list, gives an example of how, with eleven sizes of cylinders, twenty-four engines can be constructed varying in power from 30 B.H.P. to 1,000 B.H.P., and in speed from 250 revolutions per minute to 150 revolutions per minute. With the A frame form of construction (see Fig. 29) the unit consists not only of the cylinder, but also of the valves, connecting-rod and A frame itself, so that by varying the bed-plate, the shaft and the two-to-one shaft, several different sizes of engines can be built. This is an important advantage from the manufacturing point of view. A similar table (Table III.) has been prepared from the list published by the Maschinenfabrik Augsburg-Nürnberg Co. In this list there are seventeen sizes of cylinders, from which forty-five different sizes of engines are constructed. Only a few of the cylinders are shown in the table to indicate the principle. For each size of cylinder the width and height of the engine is the same, but the length varies according to the number of cylinders. This

TABLE III.

ABSTRACT FROM TABLE OF SIZES MANUFACTURED BY THE MASCHINENFABRIK AUGSBURG-NÜRNBERG CO.

Number of Lines.	B.H.P. produced at full load at speeds given below.				
One	8*	18	50	150	(250)
Two	—	36*	100*	300	—
Three	—	—	150	450*	750
Four	—	—	200	600	1000*
Revolutions per minute . .	270	250	195	167	150
Overall dimensions—					
Width	6 ft. 7 ins.	8 ft. 6 ins.	11 ft. 2 ins.	13 ft 9 ins.	16 ft. 5 ins.
Height.	6 ft. 2 ins.	7 ft. 3 ins.	9 ft. 10 ins.	14 ft. 9 ins.	16 ft. 5 ins.
Length (of engines marked thus *) including fly-wheel	4 ft. 5 ins.	8 ft. 2 ins.	10 ft. 10 ins.	22 ft. 4 ins.	31 ft. 2 ins.

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table refers to slow-speed engines; for high-speed engines a similar table could be prepared.

Beyond these powers there do not appear to be any standard sizes, but many makers are now prepared to make engines up to 2,000 H.P. and 4,000 H.P. each, and Messrs. Sulzer state that they are prepared to make engines up to 8,000 H.P. running at 105 revolutions per minute. According to Dr. Diesel, the four-stroke cycle engine may at present be regarded as the type for stationary plants from 5 H.P. up to 800 H.P. It is possible, however, that this position may be affected by improvements in the two-stroke engine. For torpedo boats and submarines, a light type of engine has been constructed in which the framing is made of manganese bronze, and such things as doors, etc., of aluminium. The weight of these engines is as low as from 40 lbs. to 54 lbs. per B.H.P., and with six cylinders they give 150 B.H.P. at 550 revolutions per minute. Larger engines with eight cylinders run at 400 revolutions per minute and give 1,200 B.H.P.

High-speed engines are made in two types, heavy and light, the former weighing about 110 lbs. per B.H.P., principally for driving dynamos direct, and the latter weighing from

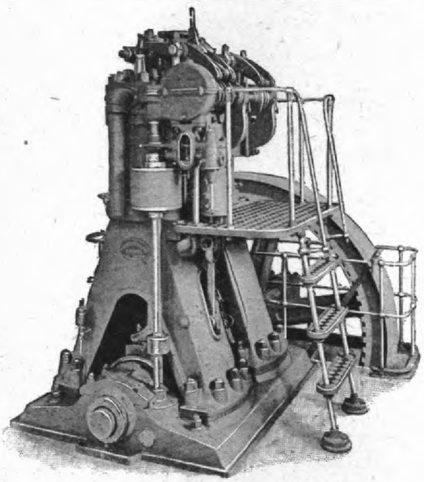

FIG. 29A.

FIG. 30.

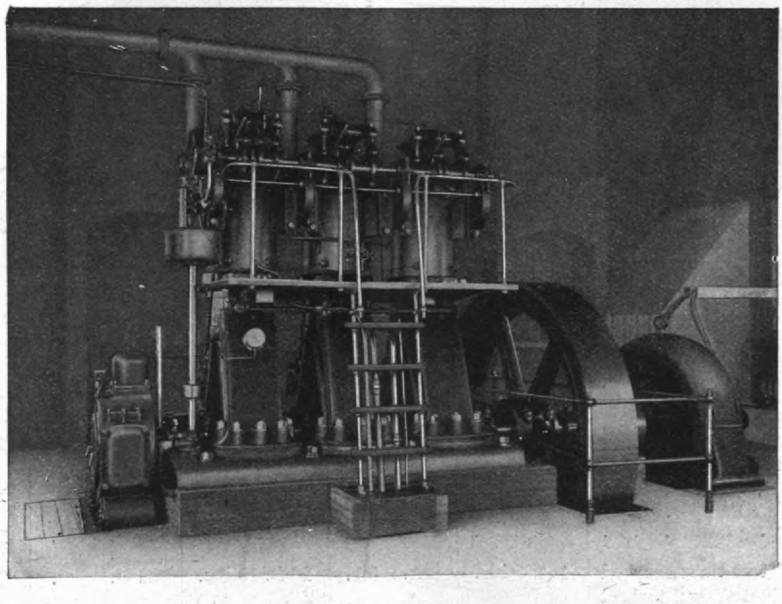

FIG. 31.

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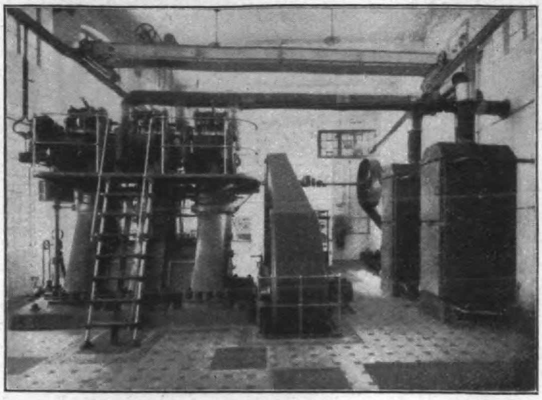

FIG. 32.

30 lbs. to 60 lbs. per B.H.P. for destroyers and submarines. The following are examples :—

B.H.P.	No. of Lines.	Revolutions per Minute.	
		Heavy.	Light.
150	6	300—400	550
600	6	225—275	450
1,200	8	215	400

FUEL OILS.

The heavy oil engine of the explosion type is much limited in respect of the kind of oil it can use, and great care has to be exercised in its selection. To obtain the best results the compression must be carefully adjusted, and a change in oil usually requires a change in the compression, for which purpose distance pieces are provided for altering the length of the connecting-rod. With the Diesel engine almost any kind of oil can be used, even animal and vegetable; for some of them, however, special arrangements are required, though, generally speaking, no alteration in the compression is needed.

A good deal of confusion exists because some of the oils have different names in the various countries; for example, what we call paraffin oil is called petrol in France, and what we call petrol is called benzine in France. In this country it is not unusual to say that "crude" oil is used with the Diesel engine. "Crude" oil, however, is in reality the natural oil as it comes from the earth, and it contains many oils which are too valuable to burn in a Diesel engine; for example, the benzines and petrols, the illuminating oils, which are also used for the ordinary oil engine, and it is only the residue—known, for example, as "Masut" or "Astaki"—which is generally used in the Diesel engine.

The characteristics of a fuel oil suitable for Diesel engines are the following: chemical composition, viscosity, specific gravity, igniting point, amount of residue, calorific value.

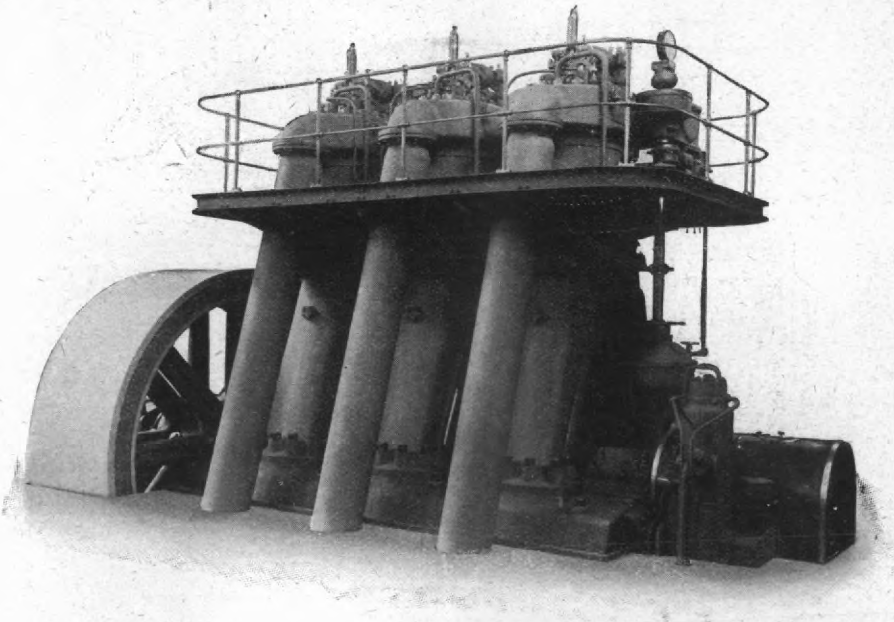

FIG. 33.

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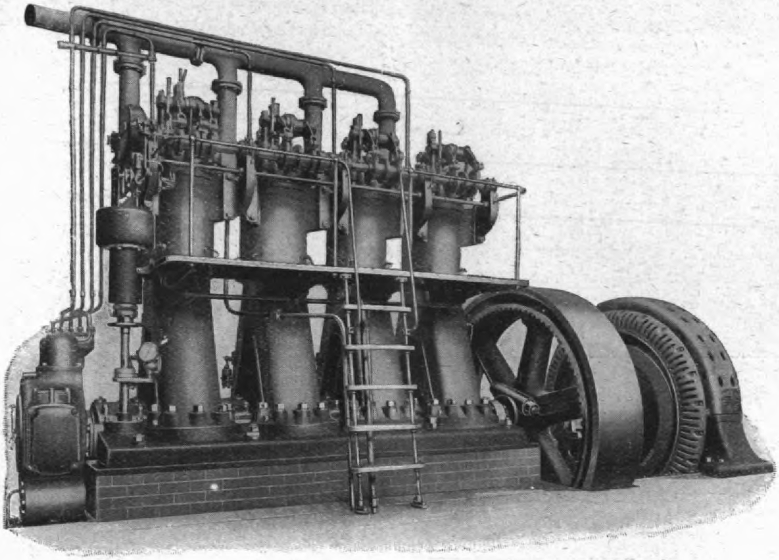

Fig. 34.

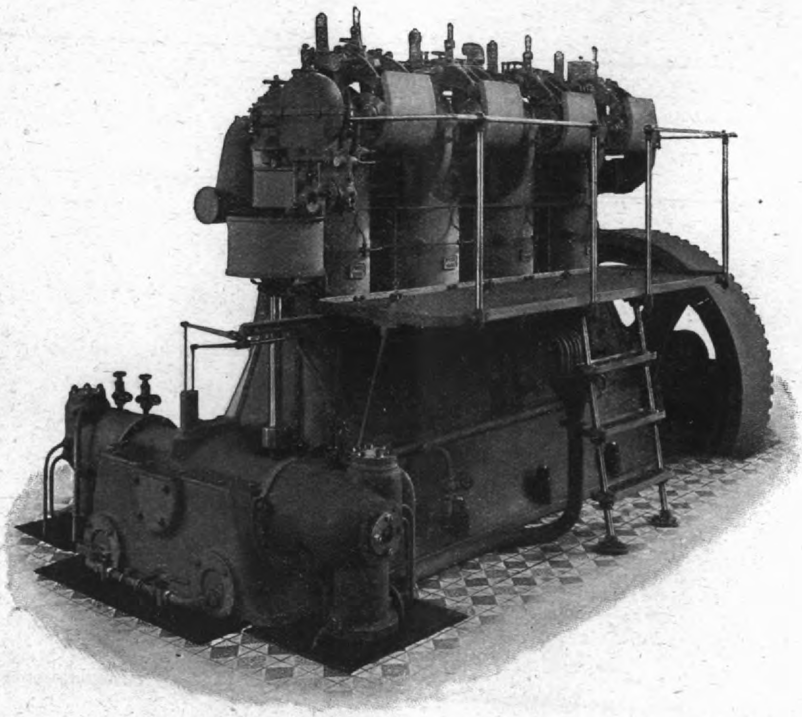

Fig. 35.

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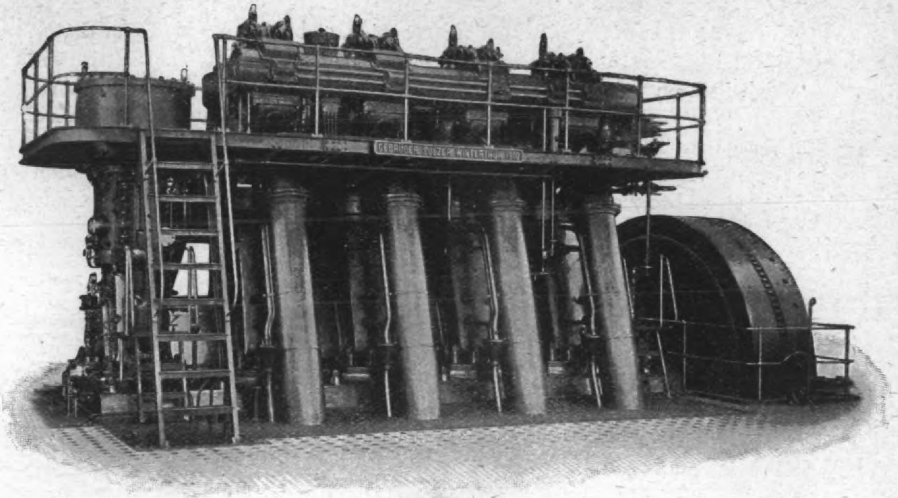

FIG. 36.

As regards chemical composition, these oils being as a rule hydro-carbons consist principally of carbon and hydrogen. In the crude petroleum the proportion by weight of carbon varies from 82 per cent. to 86 per cent., and that of the hydrogen from 11 per cent. to 14 per cent. In the coal-tar oils the proportion of carbon is about 90 per cent., and that of the hydrogen about 8 per cent. The proportion of hydrogen is important, because on it depends the capability of giving off inflammable gas to initiate the ignition even at the high temperature existing in the Diesel engine at the end of compression. If the hydrogen proportion is insufficient, as in the case of coal-tar oils, special ignition oil has to be used to initiate the combustion. Sulphur is an impurity, and must not exceed 1½ per cent.

Viscosity is not of great importance, because if it is high and the oil will not flow readily, it can be reduced to the desired point by warming the oil of the exhaust gases or by adding, say, 5 per cent. of illuminating oil.

The specific gravity is of no consequence *per se*, but is a reliable guide as to the type of oil under consideration. If the flash-point is too low danger may arise in storage, especially on board ship. Lloyd's rule is that the flash-point should not be less than 150° F. The flash-point of heavy oils, however, is over 350° F., and the lower flash-point can only be caused by the admixture of more volatile oils.

If the ignition point is too high, caused, as pointed out above, by insufficient hydrogen, a difficulty will arise with the usually adopted

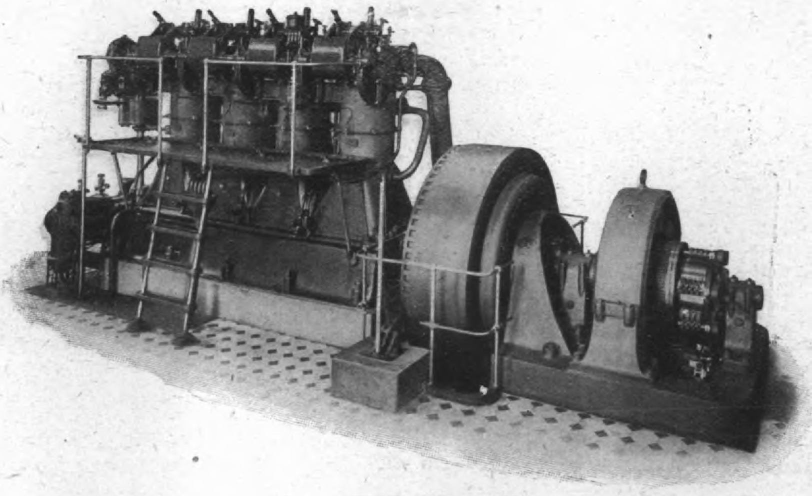

FIG. 37.

compressions of from 450 lbs. to 500 lbs. per square inch. Successful trials have been made with oils having a high ignition point by forcing up the compression to forty atmospheres, that is, about 600 lbs. per square inch; but, practically, the difficulty is got over by the use of igniting oil, which will be referred to more in detail later.

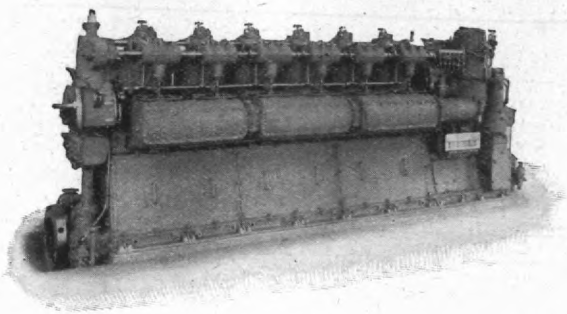

FIG. 38.

The residue should be small, to prevent accumulation on the valves, and so obviate too frequent cleaning of them.

As regards the calorific value, it is important to discriminate between what are known as the higher and lower values, the difference between them being the latent heat of the water produced by the combustion. This latent heat cannot possibly be utilised by an internal combustion engine, or by a steam boiler for that matter, and two committees of the Institution of Civil Engineers, viz., the Committee on Tabulating the Results of Steam Engine and Boiler Trials, and the Committee on Standards of Thermal Efficiency of Internal Combustion Engines, decided that the lower calorific value should be used for all calculations of thermal efficiency. The higher calorific value is that obtained in a bomb calorimeter, and if the proportion of hydrogen is known it is easy to determine the lower value, because the difference between the higher and lower values for hydrogen is 10,305 B.Th.U. per lb., and hence the following rule can be established: Lower calorific value = higher calorific value − 10,305 × H per cent.

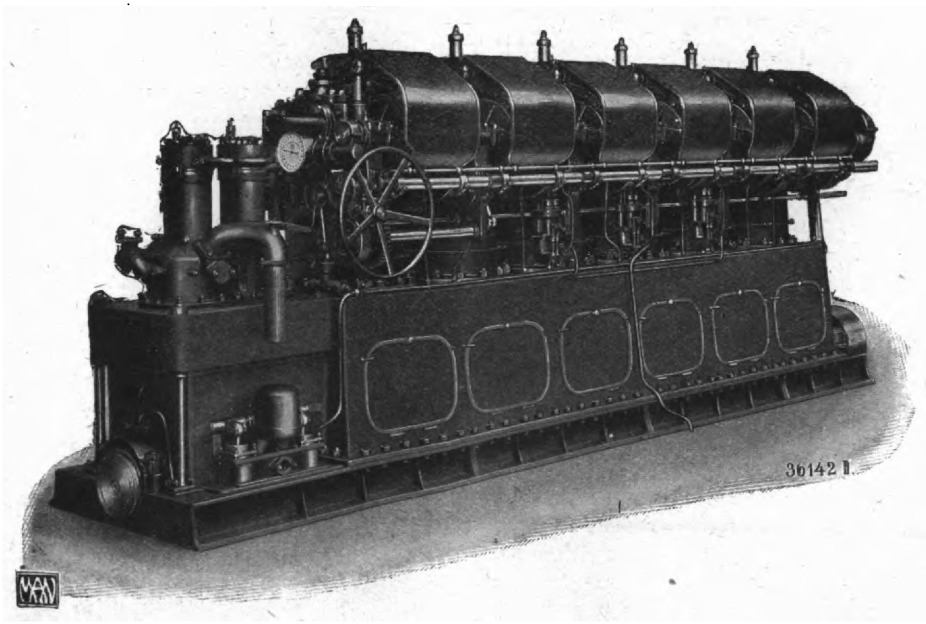

FIG. 39.

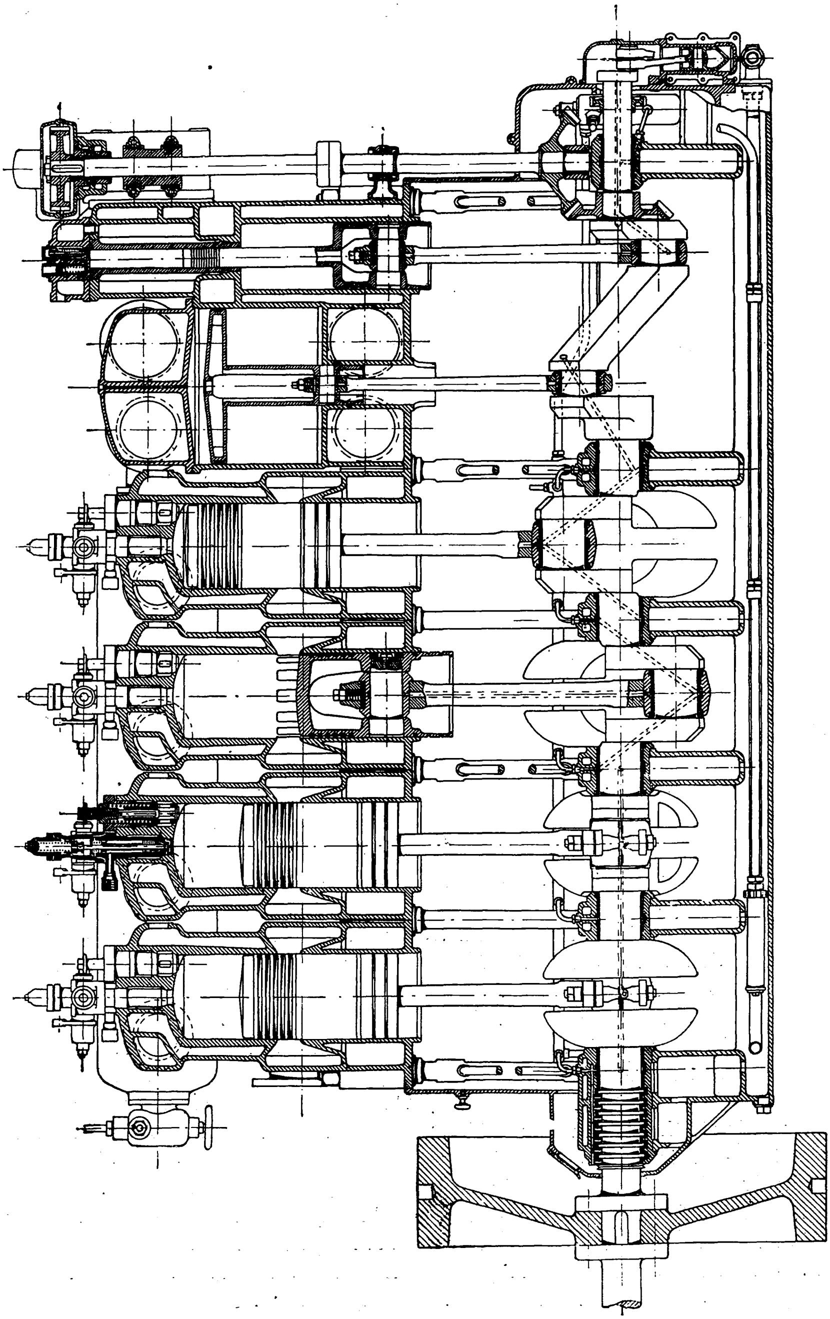

FIG. 40.

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The following table gives the calorific value, higher and lower, for several types of oils, etc.—

TABLE IV.

Description of Oil.		Specific Gravity.	Hydrogen Content. Per Cent.	Calorific Value, B.Th.U., per lb.	
				Higher.	Lower.
Petrol	Bowley's Special	0·684	—	—	19,190
	Pratt	0·719	—	—	18,610
	Shell	0·767	—	—	18,250
Russolene		0·82	14·0	19,820	18,380
Gas Oil (from brown coal)		0·825	12·3	17,900	16,630
Average "Fuel Oil"		0·89	—	—	18,000
Masut		0·90	13·9	18,600	17,170
Baku Residue		0·928	11·7	11,200	10,000
Coal-Tar Oil (creosote and autracene)		1 to 1·1	6·6	15,800	15,120

In this country petroleum oils, the largest supplies of which come from the U.S.A. and Russia, are used for oil engines. The crude or natural oil contains: (1) Light oils (spirit), specific gravity 0·65 to 0·76, which are used for petrol engines; (2) medium oils, specific gravity 0·76 to 0·86, used for illuminating and for explosion engines; (3) lubricating oils; (4) residues, from which fuel oils for Diesel engines, specific gravity 0·86 to 0·94, are obtained, together with solids such as paraffin wax and pitch.

In 1899 the oil production of the U.S.A. was about ten million tons, and that of all other countries also ten million tons. In 1910 the oil production of the U.S.A. had gone up to twenty-four million tons, and that of other countries to eighteen million tons.

In Germany, owing to the high duty on residue oils—36*s*. per ton—coal-tar oils are principally used with the Diesel engine. Originally the Diesel engine could only use oils having the relatively high proportion of 11 per cent. to 14 per cent. of hydrogen, which excluded tar oils, as they only contain 6 per cent. to 7 per cent. of hydrogen; the reason being that with the usual compression of from thirty to thirty-two atmospheres, the temperature reached is insufficient for ignition. It has been found possible to use tar oils by increasing the compression to over forty atmospheres, but as a practical matter it has been found better to retain the usual compression, and to effect the ignition by a pre-injection of ignition oil, which usually is the oil employed for making oil gas. From 3 per cent. to 5 per cent. of the ignition oil at full load is required, and the heat produced by the burning of this oil raises the temperature to the point required for the ignition of the tar oil.

The Maschinenfabrik Augsburg-Nürnberg Co. use a closed nipple. The ignition oil is injected by a separate pump, and the practice is to use a constant amount for all loads; that is to say, the amount of ignition oil is not regulated by the governor, and only the tar oil pump supply is thus controlled. In the Koerting engine the governor controls both the ignition oil and the tar oil.

The tar oil must be screened to remove solid impurities, and the water must be eliminated. This latter is a difficult matter with tar oils obtained from horizontal or inclined retorts, but the water separates easily from the oil obtained from vertical retorts.

The tar oil must be pre-warmed, say by the exhaust gases, in order to render it fluid, but the temperature must not be sufficient to cause any distillation.

Animal and vegetable oils can also be used in the Diesel engine, and the matter is now receiving much attention from Dr. Diesel.

A fuel-testing laboratory has been established at the University of Zurich under the direction

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of Professor Constan, and it is probable that a similar laboratory may be established in this country.

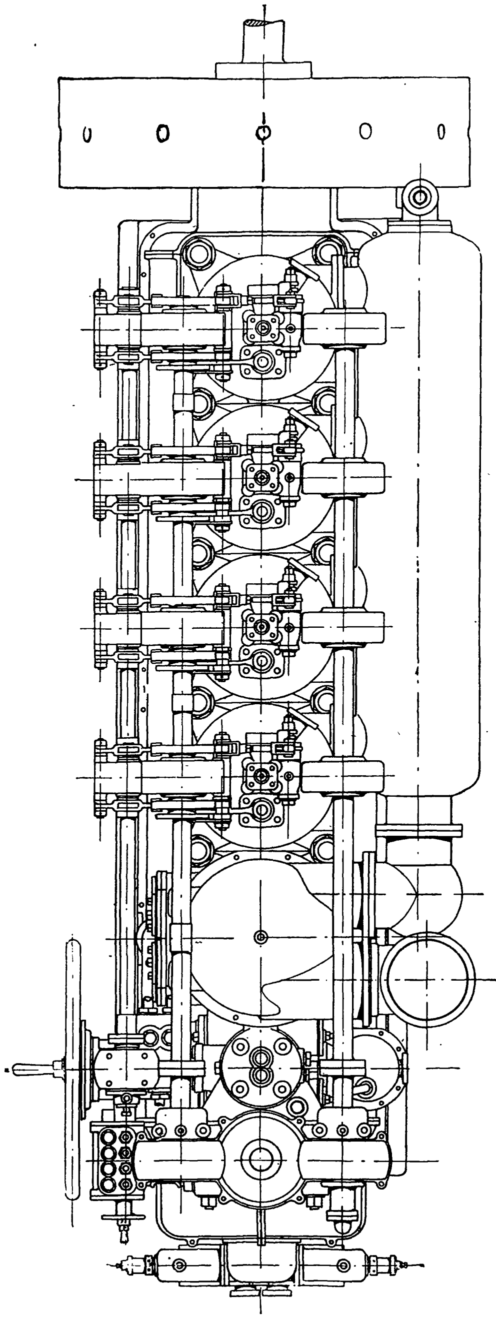

FIG. 41.

From tests and examinations already made, power oils have been divided into the following three classes:—*

* From Dr. Diesel's paper read before the Institution of Mechanical Engineers, March 15th, 1912.

1. Normal oils which can always be used:—

(*a*) Mineral oils freed from benzine (gas oils)	Hydrogen over 10 per cent. Calorific power over 10,000 cal. (39,680 B.Th.U.)* No solid impurities.

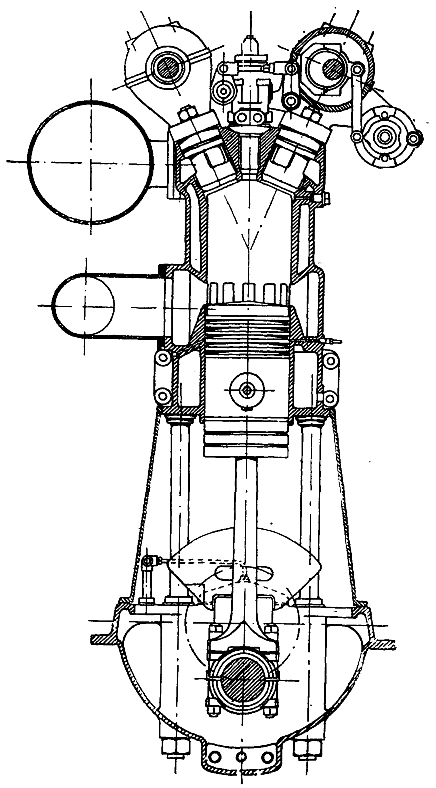

FIG. 42.

(*b*) Lignite tar oils .	Hydrogen over 10 per cent. Calorific power over 9,700 cal. (38,489 B.Th.U.).
(*c*) Fat oils from vegetable or animal sources, such as earthnut oil, castor oil, fish oils, etc. .	Scarcely any researches have been made on these. Earthnut oil has 11·8 per cent. hydrogen, and calorific power 8,600 cal. (34,124 B.Th.U.).

* Higher calorific value per kilogramme.

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2. Oils which can be used only with the aid of special apparatus:—(*a*) Pit coal-tar oil; (*b*) vertical-oven, water-gas and oil-gas tars, probably also coke-oven tars, the tests on which have not yet been completed.

General characteristics:—hydrogen not over 3 per cent.; amount of free carbon not over 3 per cent.; residue on coking not over 3 per cent.; calorific power not under 8,600 cal. (34,124 B.Th.U.).

3. Oils which cannot be used:—tars from horizontal or inclined retorts.

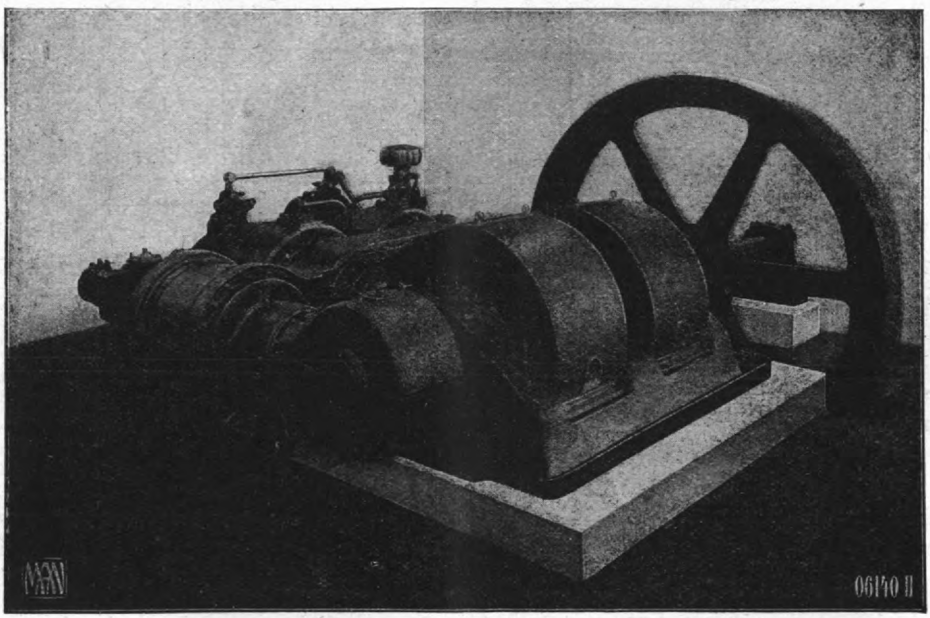

FIG. 43.

It must not be understood that these will not be used in Diesel engines under special conditions; but, on the whole, the above classification is accurate in the present state of development of the Diesel engine.

SPECIFICATIONS OF TAR-OIL SUITABLE FOR DIESEL ENGINES.

(*From the German Tar Production Trust at Essen-Ruhr.*)

1. Tar-oils should not contain more than a trace of constituents insoluble in xylol. The test on this is performed as follows:—25 grammes (0·88 oz. av.) of oil are mixed with 25 cm. (1·525 cub. in.) of xylol, shaken and filtered. The filter-paper before being used is dried and weighed, and after filtration has taken place it is thoroughly washed with hot xylol. After redrying, the weight should not be increased by more than 0·1 gr.

2. The water contents should not exceed 1 per cent. The testing of the water contents is made by the well-known xylol method.

3. The residue of the coke should not exceed 3 per cent.

4. When performing the boiling analysis, at least 60 per cent. by volume of the oil should be distilled on heating up to 300° C. The boiling and analysis should be carried out according to the rules laid down by the Trust.

5. The minimum calorific power must not be less than 8,800 cal. per kg. For oils of less calorific power the purchaser has the right of deducting 2 per cent. of the net price of the delivered oil, for each 100 cal. below this minimum.

6. The flash-point, as determined in an open crucible by Von Holde's method for lubricating oils, must not be below 65° C.

7. The oil must be quite fluid at 15° C. The

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purchaser has not the right to reject oils on the ground that emulsions appear after five minutes' stirring when the oil is cooled to 8°.

cooling of the oils in the tank during transport, the purchaser must redissolve them by means of this apparatus.

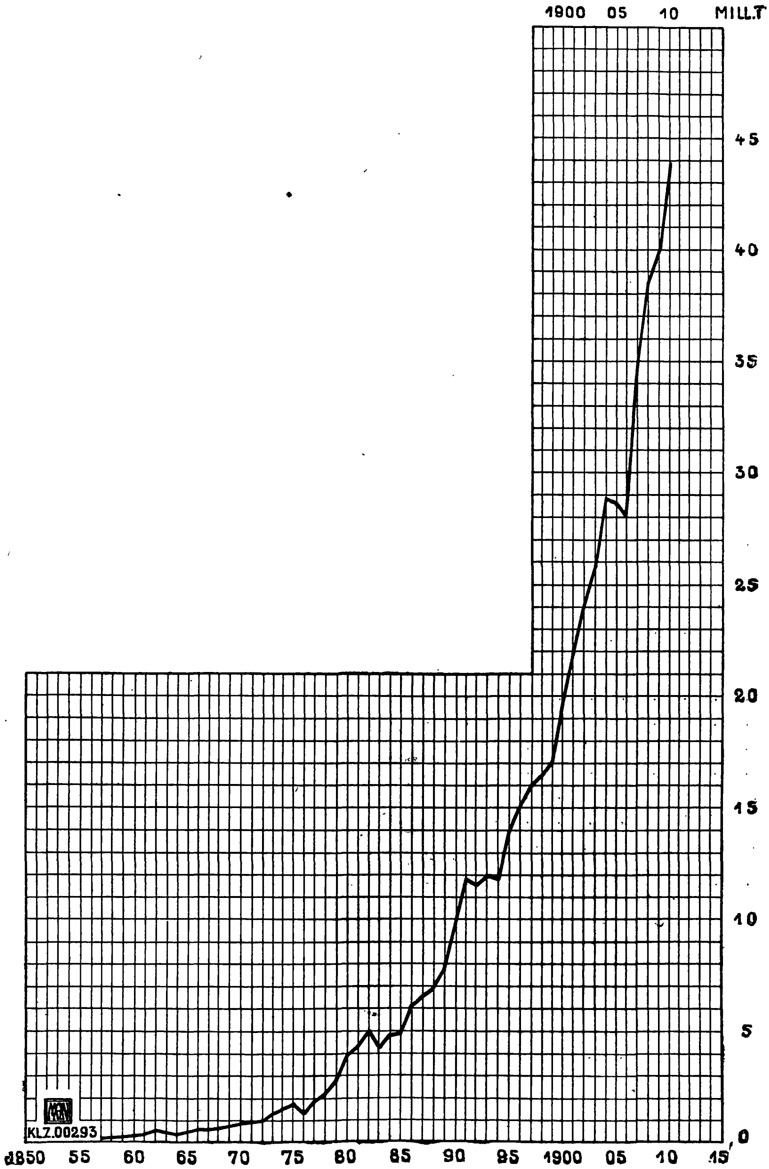

Fig. 44.

Purchasers should be urged to fit their oil-storing tanks and oil-pipes with warming arrangements to redissolve emulsions caused by the temperature falling below 15° C.

8. If emulsions have been caused by the

Insoluble residues may be deducted from the weight of oil supplied.

Fig. 44 shows the world's output of oil from 1857 to 1910 expressed in millions of tons.

(*To be continued.*)

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THE EFFECT OF HEAVY ROOT-FEEDING ON THE YIELD AND COMPOSITION OF MILK.*

The object of the experiments was to test the effect of a ration consisting largely of roots on the yield and composition of milk, and incidentally to determine how far turnips could profitably replace the more concentrated and expensive foods commonly employed in feeding dairy cattle.

Three separate experiments have been made—the first in 1909, when twenty cows were under experiment; the second in 1910–11, with twenty-two cows; and the third in 1911–12, with eighteen cows. For each experiment two lots of cows, as nearly equal as possible in respect of age, period of lactation, and yield and quality of milk, were selected from the herd. Before the experiment began there was a preliminary period of trial of about three weeks in length, in order to complete the adjustment of the two lots. During this preliminary period all the foods to be experimented with were fed. The cows were then gradually put on to the experimental rations. In experiment III., after the experimental rations had been given for eight to ten weeks respectively, the rations were crossed. The change was effected gradually, so as to introduce as little disturbance as possible, and then the experiment was continued for another four to six weeks.

EXPERIMENT III. (1911–12).

Lot I. (Turnip Ration).

	lbs.
Bean meal	2
Bran	2
Turnips	112
Hay	15

Albuminoid ratio, 1 : 14.

Total dry matter in ration . . . . . 28·6 lbs.

Lot II. (Ordinary Concentrated Ration).

	lbs.
Bean meal	2
Bran	2
Pease meal	4
Dried brewers' grains	2
Turnips	40
Hay	15

Albuminoid ratio, 1 : 7·6.

Total dry matter in ration . . . . . 26·7 lbs.

In addition, straw was fed to both lots.

The turnip ration contained only 4 lbs. of concentrated food as against 10 lbs. in the ordinary ration; on the other hand, it contained 72 lbs. more turnips, and on the average contained about 1¾ lb. more dry matter than the ordinary ration.

The cows on the turnip ration received daily nearly four and a half gallons more water per head than those on the other ration. The results showed: (1) It is not from the ration containing the greatest weight of digestible fat that the richest milk has been obtained. (2) The much larger amount of fat obtained in the milk than was given in the ration. If allowance is made for the indigestible fat in the ration the difference is even more striking. In 1911–12, for example, the turnip ration contained only 171 lbs. of digestible fat, and the ordinary ration only 247 lbs.; the yield of fat in the milk over the amount fed was 358 lbs. in the case of Lot I., and 263 lbs. in the case of Lot II. The larger secretion of fat, which has always been obtained from the cows fed on the turnip ration, appears to indicate that the easily digestible carbohydrates contained in the turnips are specially suitable for fat formation.

Summary and Conclusions.

Taking the results of the three experiments together, we may draw the following conclusions: (1) The feeding of a ration containing a large quantity of water does not increase the percentage of water in the milk, or reduce the percentage of fat. (2) In all three experiments the greater yield of milk was obtained from the cows on the concentrated ration. On the other hand, the milk from the cows on the turnip ration contained a higher percentage of fat, and a greater total weight of fat was contained in the milk.

* Abstract of paper read before the Agricultural Section of the British Association by Alexander Lauder, D.Sc., and T. W. Fagan, M.A.

COTTON-SEED OIL AS A SUBSTITUTE FOR BUTTER-FAT IN CALF FEEDING.*

In most experiments on feeding calves with separated or skim milk and an oil in substitution for the butter-fat, cod-liver oil has been the oil used. Consequently the opinion is prevalent that this is the only oil which can properly be used. The author recently carried out some experiments which were intended mainly as practical demonstrations on the economy of using separated milk and oil in substitution for whole milk in the feeding of ordinary commercial calves. In these cotton-seed oil was used as well as cod-liver oil. Cotton-seed oil was chosen as a comparatively cheap and easily obtained vegetable oil, which is extensively used in human food, and which is known to be wholesome. Another reason why it was chosen was that it was found that practical men, even of the intelligent and educated class, had a profound suspicion of it as a food for calves. This suspicion appeared to be based on the general unsuitability of cotton-cake as a food for young stock.

Three series of calves were fed during the experiments. Each series consisted of three lots treated as follows:—

Lot 1. Fed on whole milk till time of weaning.

Lot 2. Fed on whole milk till three to five weeks old, then whole milk gradually replaced by separated milk and cod-liver oil, or by separated milk, cod-liver oil, and a meal gruel.

* Abstract of paper read before the Agricultural Section of the British Association by James Hendrick, B.Sc., F.I.C.

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Lot 3. Fed on whole milk till three to five weeks old, then the whole milk gradually replaced by separated milk, cotton-seed oil, and a meal gruel.

After weaning, the calves were all treated similarly till about two years old, when they were sent to the butcher, fat. Records of the weights were kept till the time of slaughter, when the carcass weights and a report on the carcasses by the butcher were obtained.

The following table gives a summary of the results:—

—	Lot 1. Whole Milk.	Lot 2. Cod-liver Oil.	Lot 3. Cotton-seed Oil.
Total number of calves	14	15	15
Average weight at start	109 lbs.	113 lbs.	107 lbs.
Average weight at weaning	309 lbs.	290 lbs.	280 lbs.
Average increase when weaned	200 lbs.	177 lbs.	173 lbs.
Average cost of feeding to time of weaning (per calf)	£3 19*s.* 3*d.*	£1 7*s.*	£1 5*s.* 9*d.*
Average cost of food per pound of increase	4·82*d.*	1·83*d.*	1·79*d.*
Average weight when sent to butcher	1,150·3 lbs.	1,117 lbs.	1,078·3 lbs.
Average increase when sent to butcher	1,041·3 lbs.	1,004 lbs.	971·3 lbs.

The table shows that there is little difference, on the average, between the increases made by calves fed with cotton-seed oil and those fed with cod-liver oil. The cost of the cotton-seed oil feeding was slightly less. There did seem to be a distinct difference in favour of the whole-milk calves till the time of weaning. After that there was no significant difference, and at the time of slaughter the differences between the lots were so small as to be within the limits of experimental error. So far as the evidence of these experiments goes it shows that cotton-seed oil is as suitable as cod-liver oil as a substitute for butter-fat in feeding calves.

THE GUAYULE RUBBER INDUSTRY OF MEXICO.

The growth of the guayule rubber industry in the States of Durango and Coahuila has been truly remarkable. Guayule is a form of rubber extracted from the guayule plant, which grows in enormous quantities in certain of the northern States of Mexico, especially San Luis Potosi, Zacatecas, Durango and Coahuila. As late as 1904, extraction of rubber from the guayule plant was still in the experimental stage, and it was not until the following year that it appeared as an export item to the United States, £26,000 worth of crude rubber being shipped. The guayule shrub grows from one to three feet high, has a thick greyish bark, in which most of the rubber occurs, and has a general appearance not unlike that of the sage brush in the western states of America. It thrives best in the semi-arid regions of central and northern Mexico, on rocky soil, where cactus is almost the only other vegetation. Probably the most luxuriant growth of this plant occurs in the eastern and southern portions of Durango, where much land, which was considered absolutely worthless and not even fit for pasture for cattle, has in the last few years produced fabulous sums from the sale of the guayule shrub.

In 1904, when the guayule industry was in its infancy, the shrub sold for £1 per ton; the following year, £3 to £4 was paid. From that time the price gradually advanced until, at the height of the rubber boom in 1910, as much as £30 per ton was paid. The price during the year 1911, although showing a considerable decline, still averaged over £18 per ton. The Santa Catalina ranch, in the eastern part of the State of Durango, is the source of much of the guayule shrub, and has made a fortune therefrom during the last few years. The plant occurs in the wild state only; several attempts have been made to propagate and cultivate it, but they have all been more or less unsuccessful. The plant is gathered by peons, and is usually pulled up by the roots. These plants are hauled to some centrally located camp, where they are pressed into bales weighing about 330 lbs., convenient for forwarding to the factory.

The method of manufacture is comparatively simple, and consists, according to the United States Consul at Durango, only of three processes, viz., mechanical mastication, washing, and drying. The plant is first ground up into particles about the size of coarse sawdust, which are placed in pebble mills about half filled with hard flint pebbles, with sufficient water to cover the pebbles and the triturated shrub. The mills then revolve at thirty revolutions per minute for two hours. This process serves thoroughly to crush the particles, and to separate the wood from the rubber, which conglomerates in small pellets. Next it is drawn off into settling tanks, where the mixture of fibre and rubber is allowed to settle for

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several days; the wood, gradually becoming water soaked, goes to the bottom, while the particles of rubber rise to the top and are readily skimmed off. Then the rubber passes through cleansing tanks, which remove the particles of wood and other foreign substances, after which the rubber is subjected to a drying process, and then is run through presses in order to make it into a compact mass of convenient size for transportation. Under normal conditions 10 to 15 per cent. of pure rubber is extracted from each ton of guayule shrub.

Fully 70 per cent. of Mexico's guayule rubber production is worked up in the large rubber factories of the Laguna district, chiefly in the cities of Torreon and Gomez Palacio. There are seven such factories in the Laguna district, which have a combined capacity of a little more than two hundred tons of guayule shrub per day. The plant of one factory at Torreon has a capacity more than equal to that of the other six plants operating in the Laguna combined. This immense plant operates one hundred and twelve large pebble drums, each of which has a capacity for a little more than a ton of the shrub per day. This factory gives employment to about seven hundred men, and is said to be the largest single plant for extracting rubber in the world. The output of finished rubber from this one plant in 1911 amounted to between six and seven million pounds, almost all of which found a market in the United States.

It is estimated that there originally existed 500,000 tons of wild guayule shrub in Mexico, and of this fully four-fifths have been worked up since 1904. Unfortunately the plant is of exceedingly slow growth, and ordinarily requires from eight to ten years to reach maturity. Fear is entertained that the supply will soon become exhausted, and that the large factories which have been built and equipped especially for its treatment will be forced to close. In the last two or three years both the Federal Government and the large rubber companies have been experimenting with the cultivation of this valuable plant with indifferent success. It has been found impossible to propagate successfully from seed on account of the lack of fertility. Some success has been obtained in propagating by shoots from the parent plant, but when these plants reach maturity they possess a far smaller percentage of rubber than is ordinarily found in the shrub in its wild state. Others look at the situation more hopefully, and point out that it has already been seven or eight years since the first plants were gathered, and that within a year or two new plants may be expected with the required amount of rubber contents.

ENGINEERING NOTES.

The Design of Screw Propellers.—The screw was proposed to be used for the propulsion of ships by means of capstans, worked by hand, as far back as 1800, and about forty years later it was introduced to utilise the power of steam for the same purpose, successfully superseding the paddle-wheel. Quite recently aeroplanes and airships have followed this lead. Hence, it would have been thought that everything, theoretical and practical, regarding the design of the propeller would have been well known by this time. It was, therefore, surprising to most engineers who are not specially connected with marine or aerial work to hear that Sir William White, the President-elect of the next meeting of the British Association, stated recently, at the International Congress of Mathematicians at Cambridge, that the marine engineer had no help from mathematicians in designing the propeller, and that no mathematical theory had yet prevailed which had any influence on it as to form, area, or pitch.

Canadian Coal for London.—The coal supply is so important in connection with the engineering industries that it is of much interest to hear that it is proposed to supply the gas companies of the Thames with coal from Nova Scotia. That such a thing could be possible is very significant. The coal measures of Nova Scotia comprise 4,000 square miles, the best and richest of which lie in Cape Breton on the seaboard. The coal is of high quality, and is won in these collieries at a lower cost than anywhere else on the North American continent. Again, Sydney, which is the port of Cape Breton, is less than 2,000 miles from the United Kingdom, and lies in the direct line of navigation between Northern Europe and the great ports of the North American continent. The present output is 6,000,000 tons per year, and is rapidly growing; the larger proportion of this is used up by the great steel works, which have been established locally, but a great portion of the remainder is shipped to places quite as distant from the mines as the United Kingdom. Of course, it is a matter of freights compared with railway rates from home collieries; but in any case the existence of first-class coal within a reasonable distance of our shores is a comforting fact to be considered in the event of future wholesale strikes in this country.

The Machine Tool and Engineering Exhibition at Olympia.—Successful engineering exhibitions were held at Olympia and in Manchester in 1910, and two to follow were announced, one projected by the *Engineering Review*, which was to be held during the present year, and the other by Mr. F. W. Bridges, next year, both at Olympia. Judging that these schemes should be carried out by a representative body of machine and tool manufacturers, some alteration was made, and we have now the exhibition held by the Machine Tool and Engineering Association, which was opened on October 3rd at Olympia. This corporation includes a membership of over a hundred firms, each of which is pledged not to exhibit at any show not approved by the directors. But in one sense the present exhibition does not supersede that of the

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original proposals, inasmuch as the services of the organising managers of those schemes have been retained for the present one. The result is an exhibition which is much finer than any of its predecessors, not only in regard to the number of its exhibitors, which amounts to 300, but in the variety, interest, and arrangement of the exhibits. A large number of the most important machinery and engineering tool firms are represented; but there is a notable absence of the heavier class of tools, such as those used in shipbuilding yards, marine-engine and locomotive works.

Combustion in Oil and Gas Engines.—*Engineering* points out that many experiments have been made during the past three years to check the rapidity of the explosions in oil-engines, and one method adopted was to let a little water be sucked in with the charge. This greatly increased the ease of running, and made higher compressions possible without danger of pre-ignition. The National Gas Engine Co. use, instead of water, a diluent consisting of the cooled exhaust gases. In this way the rapidity of combustion with rich gases, such as coke-oven gas, is reduced, and higher compressions are practicable. The effect of water is perfectly well known, but in general it lowers the economy. In the case of petrol engines, however, which are often run with mixtures too rich, giving rise to temperatures of about 2,000° C., it might increase the economy to add water to the charge, and this plan is being thoroughly examined. More than a very small addition, however, reduces the economy.

Rails of Copper Alloy.—With the view to securing better power of resistance to wear and tear than is possessed by ordinary steel rails under heavy and fast traffic, the Union Steel Corporation of America are supplying the Chicago, Milwaukee, and St. Paul Railway with steel rails having an alloy of one-sixth of 1 per cent. of copper. There is said to be no material extra expense, and as every year the weights and speeds of railway traffic are becoming greater and greater, the result of the trial of the behaviour of these rails will be awaited by permanent-way engineers with a considerable amount of interest.

Waterproof Concrete.—The United States Geological Survey and the Bureau of Standards have recently published the particulars of some tests which have been made to determine the permeability to water of Portland cement. These show that the concrete is less permeable in the case of mixtures rich in cement, and that the permeability increases with age. The permeability, however, is not dependent altogether on the quantity of cement used, but is also affected by the proportion of coarse to fine aggregate which is employed in the composition of the concrete, that with a large percentage of fine material being less permeable than that with larger particles. Generally speaking, the tests show that concrete may be made practically waterproof at any hydrostatic head, up to forty feet, without the use of any special waterproofing material, of which about forty different kinds were tried. The report points out, however, that this result is only arrived at by the use of the very best materials, put together in the best way, and that the addition of waterproof compounds does not in any way compensate for a lean mixture, poor materials, or improper mixing. None of the compounds tried reduced the absorption materially before the samples were dried by heating at 212° F., but some did decrease the absorption after the samples were so dried. The addition of waterproofing compounds does not appear to have affected the strength of the concrete.

Electrically-driven Vessels.—At the Mare Island Navy Yard, San Francisco, was launched recently the collier "Jupiter." It is the first example of electric ship propulsion on a large scale. She is 572 feet long by 65 feet beam, and has a carrying capacity of 12,500 tons of coal and 375,000 gallons of fuel oil. The equipment will consist of a turbo-alternator and two induction motors. The generator is a six-stage Curtis turbine connected to a bi-polar alternator. The speed at fourteen knots is about 2,000 revolutions per minute, working at about 2,200 volts. Notwithstanding the roundabout conversion of power from steam to electrical and from electrical to mechanical, an experienced authority on the subject expects that the "Jupiter" will show a good steaming economy in comparison with the two sister vessels, of which one, the "Cyclops," is fitted with reciprocating machinery, and the other, the "Neptune," with Westinghouse turbines and reduction gear. The machinery for the "Jupiter" was manufactured by the General Electric Co. of New York. An electrically-driven vessel of 2,400 tons is being built at Wallsend-on-Tyne for service on the Canadian canals and lakes. On this ship there are two high-speed Diesel oil motors, which operate electric generators, and the electric motor turns the propeller shaft.

CORRESPONDENCE.

COLONIAL REPRESENTATIVE GOVERNMENT.

In the *Journal* of October 11th, under the heading of "Empire Notes," mention is made of the claim of the Nova Scotian Assembly to be the oldest legislative body in the present Colonial Empire, with a statement to the effect that this might be contested by Bermuda and Barbados. None of these Colonies, however, was the first in the field, as Sir Charles Lucas has rightly pointed out in his "Historical Geography of the West Indies." Priority must be given to Virginia, which Colony was granted representative institutions in 1619, just one year prior to a similar grant in the case of Bermuda. It must be remembered, too, that a "grant" did not necessarily imply the immediate establishment of parliamentary government. In

the case of Barbados, the patent granted to the Earl of Carlisle in 1627 empowered him and his heirs to make laws "with the consent, assent and approbation of the free inhabitants of the said province or the greater part of them thereunto to be called, and in such form, and when, and as often as he or they, in his or their discretion, shall think fit and best."

There is little doubt that for several years after the first settlement, the government of the island was carried on by the Earl's representatives with a Council chosen by the Governor for the time being, and it was not until after the advent of Captain Philip Bell in 1641, who was appointed Lieutenant Governor, that a proper Assembly was convened. This officer was, in 1645, appointed Governor-in-Chief "for his prudent and moderate deportment during the exercise of his trust as Deputy-Governor."

It is not certain in what year the first meeting took place. There were several Acts passed during Governor Bell's *régime* bearing no date, but he held the office of Governor until May, 1650, when he was succeeded by Francis Lord Willoughby.

G. T. Carter,
Late Governor, Barbados.

GENERAL NOTES.

Brewers' Exhibition. — The Thirty-fourth Annual Exhibition and Market of the Brewing and Allied Trades will be held at the Royal Agricultural Hall, Islington, N., from the 19th to the 25th inst. This year an important feature will be found in the increased number of machinery exhibits, many of which will be shown in motion. The Exhibition is one which, from a business point of view, appeals to a wide circle, besides having a large claim upon the attention of the public in general, affording as it does an insight into the methods of several important industries. The various competitions, too, which have resulted in so much good, are interesting features of this annual show. They number seven — a malting and seed-barley competition, cider and perry, hop, beer, non-intoxicating beverages, Colonial wines and Scotch whisky competitions, the last being introduced this year for the first time.

The Military Aeroplane Trials.—Mr. A. E. Berriman, whose paper on "Aeroplane Efficiency" won him one of the Society's silver medals last session, has just published a little pamphlet entitled "Analysis of the British Military Aeroplane Trials, 1912." It contains tabulated results of the performances of the various machines which competed in the trials held on Salisbury Plain last August, an article by Mr. Berriman on the use of the constant x in the analysis of the trials, and a reply by Mr. G. Holt Thomas. Several interesting and important points are discussed, such as the efficiency coefficients of the competing machines, and their comparative safety. The relation between these two factors is certainly a point that requires careful investigation.

A Year's Work at the Mint.—The report of the Deputy Master and Comptroller of the Mint for 1911 [Cd. 6362] contains the usual detailed statistics, and is illustrated with excellent reproductions of coins, seals, and medals. Illustrations are given of the new Great Seal of England, which resembles the famous Brétigny Seal of Edward III., and of the new Counter Seals of the United Kingdom and of Ireland, in which the King is represented as an Admiral of the Fleet, standing on the deck of a battleship of the "Dreadnought" type. Owing to the Coronation and the Prince's Investiture, there was a large increase in the demand for medals, the number issued being 57,347, as compared with 11,124 in the year before. The gross profit realised by the sale of Coronation and Investiture medals and specimen coins was £6,364 18*s.* 11*d.*, the amount received in cash being £42,599 15*s.* 6*d.* The general account shows a profit of £374,266, as against £1,503,939 in 1910, the decrease being mainly attributable to changes in accounting. The demand for gold coins continued to increase, the number struck being more than two-and-a-half times the average of the previous ten years. About two million fewer bronze coins were struck than in 1910.

The Concrete Institute.—A course of six educational lectures on "Concrete: its Properties and Manufacture," will be given by Mr. H. Kempton Dyson, Secretary of the Concrete Institute, at 5.30 p.m., on November 12th, 19th, 26th, December 3rd, 10th, and 17th, 1912. The lectures will be given in the lecture hall of the Concrete Institute, at Denison House, 296, Vauxhall Bridge Road, Westminster.

MEETINGS FOR THE ENSUING WEEK.

Monday, October 21 ... Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Mr. C. Sheather, "The Care and Management of Brewers' Horses."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W. Mr. P. L. Marks, "The Hygiene of Buildings."

Mechanical Engineers, Institution of (Graduates' Section), 8 p.m. Mr. W. J. Maize, "Sewage-Disposal Machinery."

Tuesday, October 22...Photographic, 35, Russell-square, W.C., 8 p.m. Mr. J. McIntosh, "The Autochrome Process." Section I.—Elementary.

Wednesday, October 23...Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria embankment, W.C., 8 p.m. Mr. G. C. Allingham, "Scientific Shop Management on the Taylor System."

Royal Society of Literature, 20, Hanover-square, W., 5 p.m. Mr. C. C. Stopes, "The Founders of the Globe Theatre."

Thursday, October 24...Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. Alfred Hands, "Thunder and Lightning."

Friday, October 25...Mechanical Engineers, Storey's Gate, Westminster, S.W., 8 p.m. Professor W. E. Dalby, "Characteristic Dynamical Diagrams for the Motion of a Train During the Accelerating and Retarding Periods."

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Journal of the Royal Society of Arts.

No. 3,127. VOL. LX.

FRIDAY, OCTOBER 25, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

HEAVY OIL ENGINES.

By Capt. H. Riall Sankey, R.E. (Retired), M.Inst.C.E.

Lecture IV.—Delivered May 20th, 1912.

Testing of Oil Engines.

The testing of Diesel and oil engines is comparatively easy, at any rate so far as measurements of the fuel are concerned, and in this respect presents a great contrast to the difficulties arising in testing steam engines and boilers, or gas engines and producers. The simplest method of weighing oil is to fit the tank supplying the oil to the fuel valve with a pointed hook gauge. Assuming the level of the oil to be above the point of the gauge, as this level sinks a moment will arrive when the point of the gauge will emerge from this surface, and can be snapped on a stop watch. Later, a weighed quantity of oil is emptied into the tank, sufficient in amount again to cover the point of the hook gauge. The moment at which the point again issues is taken on the stop watch, and the interval thus recorded is obviously the time needed to consume the weighed amount of oil; this process can be continued as long as desired, and if the load on the engine is constant and the same weight of oil is emptied into the tank each time, the time intervals ought to be substantially the same.

As regards measurement of power, the engine can either be made to drive a calibrated dynamo, in which case the kilowatts are measured, or a brake is used, usually of the hydraulic type. Fig. 45 shows a 750 h.p. two-stroke engine being tested by means of a Heenan and Froude hydraulic brake.

Fuel Economy at Various Loads.

Fig. 46 shows indicator diagrams taken at varying loads. It will be noticed that the compression is constant, and that the area of the diagram is reduced by reducing the approximately constant pressure part of the diagram, which means that less fuel is used, and that the time of combustion is shortened. The action is similar to altering the cut-off of a steam engine. In this case the revolutions remain constant, which is the usual condition for land engines. In the case of marine engines, however, the load is reduced by diminishing the number of revolutions; in this case the oil consumption per diagram remains approximately what it is at full load, and the brake efficiency also remains nearly constant instead of diminishing as it does when the revolutions remain constant. The effect is that the oil consumption per B.H.P. is more nearly constant at all loads than it is in the case of constant revolution engines. The following published results illustrate this point:—

B.H.P.	lb. per B.H.P. hour.	
	Chalkley.	Sulzer.
400	0·473	0·471
300	0·475	0·471
200	0·496	0·477
100	0·493	0·546

The above results are those obtained on test, but it would appear that they are substantially maintained in actual work. A special advantage of the Diesel engine is that it only consumes fuel when actually running, and it is able to start immediately and stop immediately; this latter advantage is not shared by any other prime heat mover except petrol engines. In the case of the steam engine the steam has to be got up in the

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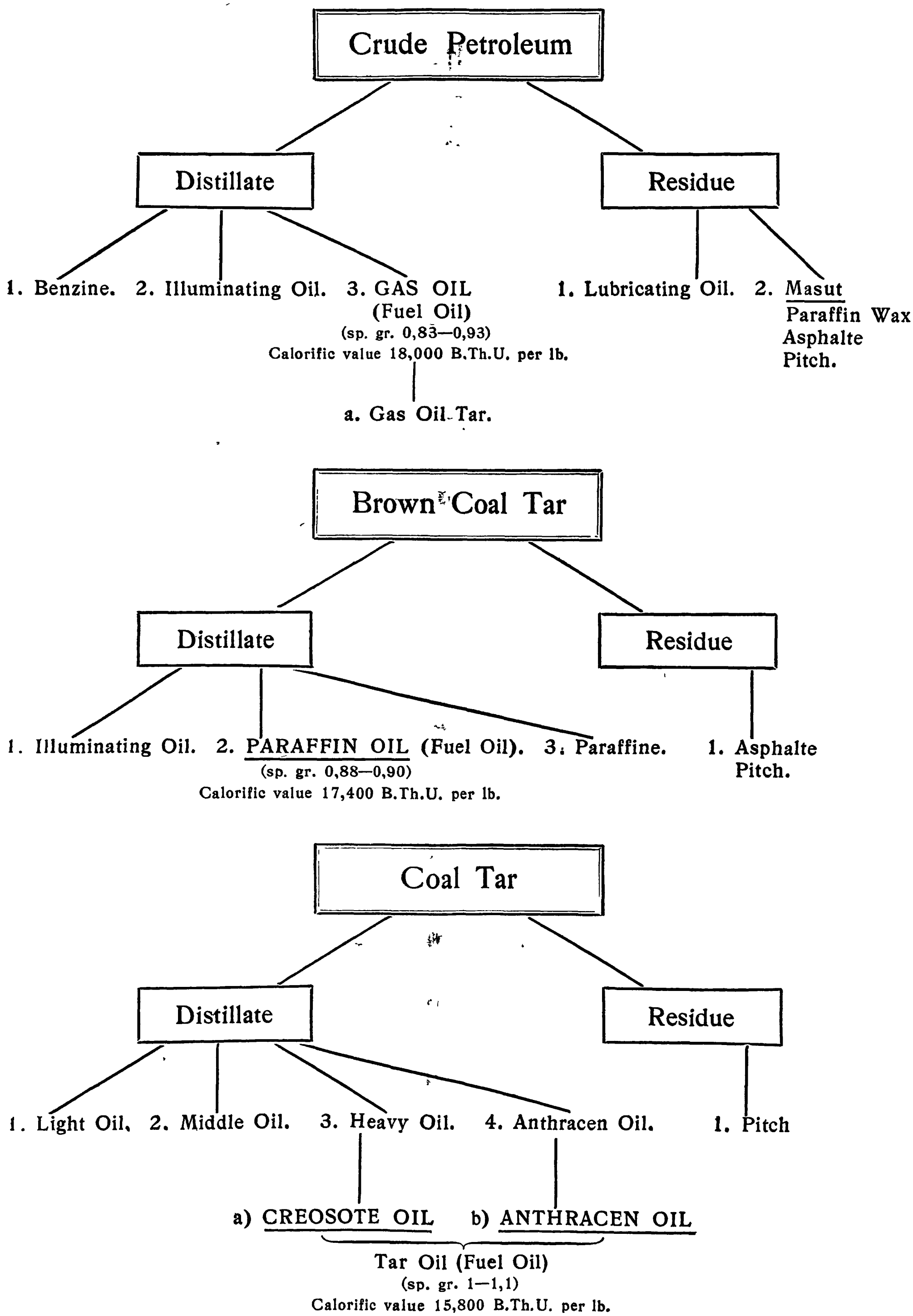
TABLE V.

Chart of the Principal Fuel Oils.



(This table is reproduced by permission of the Maschinenfabrik Augsburg-Nürnberg Co.)

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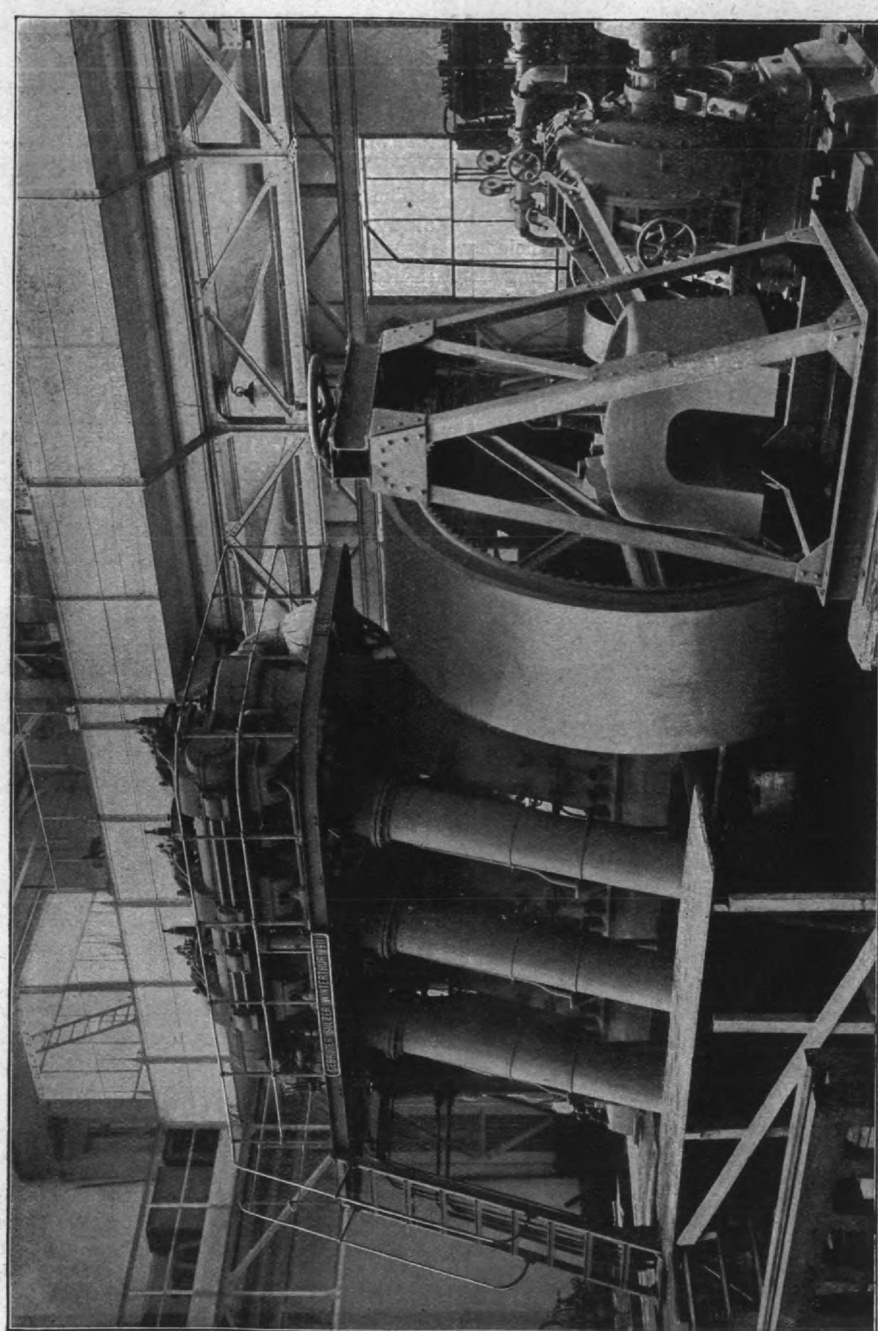

FIG. 45.

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boiler, and when the engine is shut down there is still a large amount of unutilised heat in the unburned coal on the grate, in the heat in the boiler setting, in the water in the boiler, etc. With a gas engine time is required before the producer can make gas, and when the engine is shut down a considerable amount of fuel is left in the producer. In the case of other heavy oil engines the hot bulb has to be heated by means of a lamp; there is, however, no fuel wasted on stopping the engine.

In Fig. 10, which referred to the case of a four-stroke engine, the brake thermal efficiency was given as 31·0 per cent., and assuming the calorific value of the fuel to be 18,500 B.Th.U.

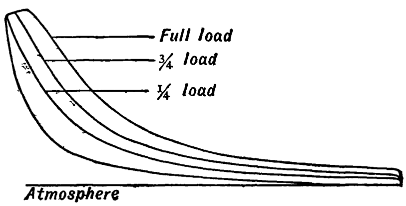

FIG. 46.

per lb., the heat converted into work on the shaft will be 18,500 × 0·319 = 5,740 B.Th.U. per lb. of oil consumed. Hence the consumption of oil per B.H.P. at full load would be 2,545 ÷ 5,740 = 0·443 lb.

In the case of the two-stroke engine the brake thermal efficiency would be reduced to 29·7 per cent., and the oil consumption increased to 0·46 lb. per B.H.P.

The above figures relate to the full rated load of the engine as given in price lists, and the makers generally guarantee a 10 per cent. overload for, say, two hours, but with a slightly increased consumption. As the load diminishes the oil consumption per B.H.P. increases. The following is a typical guarantee, expressed in lb. of oil per B.H.P. (calorific value 18,500):—

Quarter.	Half.	Three-quarter.	Full.	10 per cent. Overload.
0·64	0·50	0·45	0·448	0·458

Considerably better results than these are obtained. Those given in Table VI., published by the Maschinenfabrik Augsburg-Nürnberg Co. (converted to English units and English horsepower) appear to be about the best.

The consumption of Diesel oil engines is always quoted per B.H.P., and this is as it should be in respect of the user; but from the scientific point of view it is desirable to know what the consumption is per indicated horsepower. In this connection it is to be observed that the area of the indicator diagram in the case of the Diesel engine represents a power greater than the true indicated power which is defined as the power produced in the cylinder by the combustion of the fuel. In the case of the Diesel engine a certain amount of the power required for compressing the pulverising air is recovered in the cylinder by admission of the high-pressure air. To give an idea of the effect of this recovery of power, let it be assumed that the oil consumption is 0·45 lb. per B.H.P.-hour, and that the ratio of the B.H.P. to I.H.P. shown by the actual indicator card or "card I.H.P." is 76 per cent.; then the oil per "card I.H.P." will be 0·45/0·76 = 0·342. It may also be assumed that the power shown by the indicator cards of the air-compressor is 7 per cent. of that shown by the indicator card of the engine cylinder, and if 5 per cent. is recovered—that is to say, if the indicator card is reduced by 5 per cent.—then the oil consumption per true I.H.P. will be increased to 0·342 × 1·05 = 0·359.

TABLE VI.

Where Running.	Size. B.H.P.	Oil used and Calorific Value, B.Th.U., per lb.	Load.	Oil Consumption. lb. per B.H.P. hour.	Thermal Efficiency per B.H.P. Per Cent.	By whom Tested.
Manufacturing Co., J. L. Skworzow, Sereda, Russia.	800	Galician Gas Oil, 18,060.	$\frac{4}{4}$	·366	38·4	Consulting Engineers, Perelmann and Heally, Moscow.
	4		$\frac{3}{4}$	·375	37·5	
	Cylinders.		$\frac{1}{2}$	·414	34·0	
Parma, Officina Elettrica Comunale.	500	Gas Oil and Masut mixed, 18,000.	$\frac{5}{4}$	·390	36·2	Testing Commission (Professor Ferraris, Engineers, Dainoni and Carpani).
	4		$\frac{4}{4}$	·379	37·3	
	Cylinders.		$\frac{3}{4}$	·405	34·9	

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Mr. Dugald Clerk thinks that the whole 7 per cent. should be deducted, in which case the oil consumption per true I.H.P. would be increased to 0·366. The subject is somewhat difficult, and has not yet been fully considered.

The figures given above refer to full load, and corresponding figures for other loads are given in Table VII. It will be noticed that the oil consumption per I.H.P. diminishes as the load gets less.

In Fig. 47 is shown the heat chart diagram of a Diesel engine, and, for comparison, that of a gas engine, and also of an explosion heavy oil engine. In the case of the two latter, as already explained, the admission of heat theoretically takes place at constant volume, and the abstraction of heat also takes place at constant volume. Assuming constant specific heat, it can be shown that each element of the heat introduced has the same thermal efficiency. Actually, however, the

TABLE VII.

	Quarter load.	Half load.	Three-quarter load.	Full load.	10 per cent. overload.
Per B.H.P.	0 64	0·50	0·45	0·448	0·458
Card I.H.P.	0·29	0·51	0·32	0·342	0·354
True I.H.P. . . .	0·305	0·325	0·336	0·359	0·372

The following comparison* of a slow-speed and a high-speed Diesel engine of 250 to 300 B.H.P., driving a dynamo, will be of interest. Both engines were of four-stroke type, single-acting. They had a two-stage vertical air-compressor, compressing from atmosphere up to fifty atmospheres to seventy atmospheres, and driven by an overhanging crank. The speed could be altered from 400 revolutions per minute to 150 revolutions per minute, the engines being intended for ship-driving.

Description.	High Speed.	Low Speed.
Length	3,655 mm.	4,275 mm.
Width	1,060 ,,	2,000 ,,
Height	2,120 ,,	3,375 ,,
Weight without fly-wheel	11,800 kg.	22,900 kg.
Cost	15% to 20% less than low speed.	
Oil consumption (grammes per B.H.P.)—		
Overload	205	205
Full load	195	195
Three-quarter load .	215	215
Half load	235	240

At full load the brake efficiency in both cases was 0·78.

These engines were worked with the following oils:—Crude naphtha of 0·88 sp. gr.; solar oil of 0·883 sp. gr.; a mixture of 70 per cent. solar oil and 30 per cent. masut 0·88 sp. gr., and with masut 0·9 sp. gr.

It will be interesting to determine what the oil consumption ought to be from theoretical considerations, and it is proposed to do this by means of the heat chart described in Lecture I. (Fig. 8).

* Lee.

specific heat increases with temperature, and the constant volume lines shown in Fig. 47 have been drawn taking account of the increase of specific heat according to the figures given by Mr. Dugald Clerk in his paper for the Institution of Civil Engineers. The effect of this increase of specific heat is to make the slope of the constant volume line for admission less

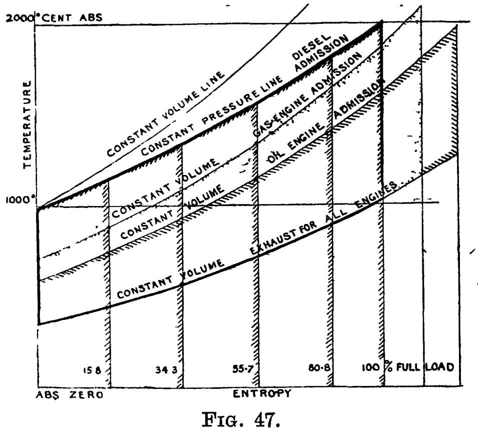

FIG. 47.

than that for the exhaust, and, consequently, the thermal efficiency of elements of heat added at the higher temperatures is less than that of those added at the lower temperatures. This effect, however, is greatly increased in the case of the Diesel engine, as will be obvious from the figure by comparing the constant volume and constant pressure lines drawn through the initial point of combustion.

In the case of the Diesel engine, the power is reduced by diminishing the oil supply, and on

the diagram this is expressed by reducing the area, which corresponds to the amount of heat produced per stroke at full load. Four cases have been taken in Fig. 47, and the percentage of full load is indicated in the left-hand bottom corner of each area. From these the theoretical indicated thermal efficiency for each of these loads can be obtained by measuring the respective areas; this has been done, and the result is given in Fig. 48, and it will be seen that all the points lie sensibly in a straight line, and that the thermal efficiency at no load is 65 per cent. and at 10 per cent. overload it is reduced to 55 per cent.

Results of tests made by the lecturer on a three-throw 225 B.H.P. engine at Messrs. Willans and Robinson's works in 1909 have also been inserted in this figure. It will be seen that the actual thermal efficiency per I.H.P. at the various loads tested also lies very nearly in a straight line. The ratio between the actual thermal efficiency and the theoretical thermal efficiency gives the efficiency ratio, and this has also been plotted on the figure, and it will be seen that the efficiency ratio is greater at light loads than it is at full load within the limits of the test, as might be expected, because within these limits the combustion will probably be equally good, and as the temperatures at light loads are less than at full load there will be less loss, and therefore a better efficiency ratio. At heavier loads and at much lighter loads the combustion may become more imperfect and the efficiency ratio will then be reduced.

Returning to Fig. 48, the reason for the lesser thermal efficiency of the gas engine and of the ordinary oil engine is obvious; in the cases given, at full load the theoretical thermal efficiencies are, respectively: Diesel oil engine, 57 per cent.; gas engine, 51 per cent.; explosion oil engine, 41 per cent.

In Fig. 48 the brake thermal efficiency is also shown, deduced from the experiments for the tests referred to above. The power required for driving the engine was found to be sensibly 69 h.p., and the effect on economy is clearly shown by the curvature of the brake efficiency line. At full load the best figure is obtained; at light loads the improvement in indicated thermal efficiency is overshadowed by the loss due to the brake loss; and above full load, although the brake efficiency is better, the brake thermal efficiency is less because of the reduced indicated thermal efficiency.

The total fuel used per B.H.P. is plotted in Fig. 49 on a load base, and it will be seen that it nearly follows a Willans line, which if produced cuts the origin at a point showing an oil consumption of 19 per cent. of the full load fuel; that is to say, that the engine, when running light, requires 19 per cent. of the full load fuel. On producing the line showing fuel consumption per I.H.P., it is found that 0·28 lb. of oil is required per I.H.P., and as the brake loss is 69 h.p., the oil consumption works out to $0 \cdot 28 \times 69 = 19 \cdot 3$ lbs., which is 19·3 per cent. of the total fuel per hour, namely, 100 lbs., and, therefore in good agreement with the figure previously obtained.

The I.H.P. and B.H.P. lines are also plotted on Fig. 49, and it will be seen that these lines are sensibly parallel, that is, the power required to drive the engine and the air-compressor was 69 h.p. at all loads, and since the full load is 225 B.H.P. the percentage is 30·7. The approximate constancy of the difference between the I.H.P. and the B.H.P. appears to be

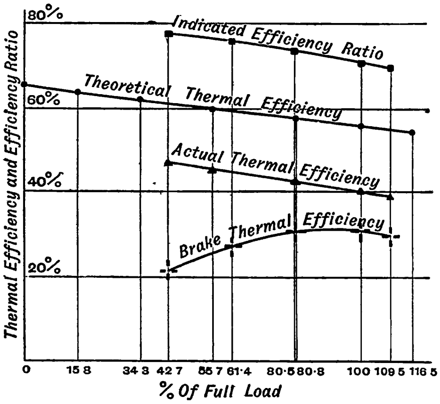

FIG. 48.

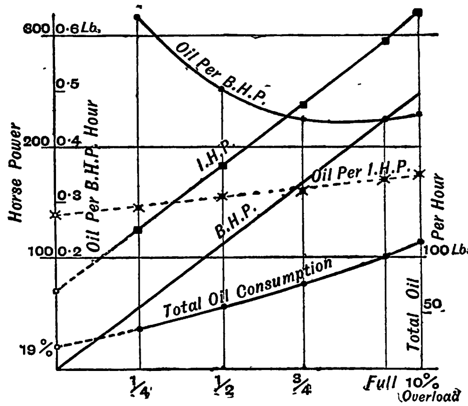

FIG. 49.

general with Diesel engines, as is shown by Table VIII., deduced from actual guarantees, the percentage varying, however, with the size of the engine, whether vertical or horizontal, and whether of the four-stroke or two-stroke type.

Table IX. has been prepared, giving various typical cases, which shows that the Diesel engine is easily at the head.*

In many industries a prime mover is required that has to give occasionally for short periods a considerably greater power than the average.

TABLE VIII.

Description of Engine.	Percentage difference between I.H.P. and B.H.P.					
	Size. B.H.P.	Quarter load.	Half load.	Three-quarter load.	Full load.	10 per cent. Overload.
Sulzer, Vertical 2-stroke, 136 r.p.m.	1000	36·0	36·4	37·0	39·0	—
Carels, Vertical 2-stroke, 200 r.p.m.	1000	37·5	37·7	40·4	43·0	—
M.A.N., Horizontal 2-stroke, 150 r.p.m.	1000	30·6	30·6	30·7	30·0	—
Krupp, Vertical 2-stroke, 150 r.p.m.	1000	—	33·4	37·0	35·0	—
Burmeister and Wain, Vertical 4-stroke, 150 r.p.m.	1000	25·0	26·2	26·3	26·6	—
Willans and Robinson, Vertical 4-stroke, 200 r.p.m.	225	30·8	30·6	30·6	30·7	31·2

TABLE IX.

Description of Plant.	Calorific Value of Fuel, B.Th.U. per lb.	Total Fuel Required—lbs. per Hour at Various Proportions of Full Load.				
		Quarter load. 25	Half load 50	Full load. 100 B.H.P.	10% Overload. 110	50% Overload. 150
Non-condensing Steam Plant	13,000	150	190	270	290	—
		200	240	320	340	410
Condensing Steam Plant	13,000	95	120	190	210	310
Overtype Superheated Condensing Steam Plant	13,000	55	75	130	150	230
Gas Engine Pressure Producer	13,000	37	59	93	—	—
		53	70	104	110	140
Gas Engine Suction Producer	14,000	34	53	85	—	—
		49	64	96	104	130
Oil Engine	19,000	26	40	65	—	—
		33	46	72	78	97
Diesel Engine	18,500	16	25	45	51	—
		19	27	45	50	69

COST OF RUNNING IN COMPARISON WITH OTHER PRIME MOVERS.

It will be of interest to make a comparison of the fuel consumption of oil engines with that of other prime movers, and for this purpose

In such cases the condensing steam engine has an advantage, because it can for short periods

* In most of the items two lines are given. The first refers to an engine whose rated load is 100 B.H.P., and the second to a larger engine capable of developing 150 B.H.P.

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give as much as 50 per cent. above the rated power. In this connection, it may be pointed out that under similar circumstances the non-condensing engine can give 10 per cent. above the rated power and the Diesel engine can also give 10 per cent. above the rated power, but the gas engine, as usually rated in makers' price lists, can only do its rated power for short periods, and only 85 per cent. of that continuously. It is not only the cost of fuel that has to be taken into consideration when determining which is the best prime mover to use in any particular case, as the interest on capital, labour, depreciation, repairs, etc., must also be taken into account. To give some idea what this means, Table X. has been prepared. Assuming that the average load is 200 B.H.P., and that for short periods 300 B.H.P. is required, the rated powers of various prime movers would, therefore, be as follows:—

Non-condensing steam engine . .	270 B.H.P.
Condensing steam engine	230 „
Overtype superheated condensing steam engine	230 „
Gas engine	300 „
Oil engine	300 „
Diesel engine	270 „

In Table X. the estimate for capital cost includes boilers, foundations, producers, building, etc. The cost of repairs, maintenance, and labour, has been also estimated, and the plant is assumed to be run for 3,000 hours per year. The cost of fuel has been taken as follows:—

Oil	42s. per ton.
Coal for pressure producers . . .	18s. „
Coal for suction producers . . .	28s. „
Coal for steam boilers	18s. „

It will be seen that the annual cost of running the overtype superheated steam engine is £53 less than that of the Diesel engine when all conditions and items of expense are taken into consideration. The conditions assumed are not at all unusual for small plants, but obviously they may be so varied as to produce very different results, and each case must be considered on its own merits, but the above will give an idea how to proceed. Especially is it easy to make a correction should the price of fuel vary from that given above. Thus if the price of fuel oil is increased to 55s. a ton, the cost for fuel for Diesel engines would be $252 \times \frac{55}{42} =$ £330, and hence the annual cost would be increased to £1,010.

[A number of slides were exhibited, showing applications of the Diesel engine to various purposes, such as driving a cotton mill, application to power-stations of various kinds, marine propulsion of torpedo-boats, yachts, tug-boats as auxiliaries for large sailing vessels, and Durtnall's application to a locomotive, in which a Diesel engine drives an alternating dynamo —which in its turn drives induction electric motors placed on each axle.]

Fig. 50 shows an electric power-station driven by vertical engines, and Fig. 51 a similar station

TABLE X.

Description of Plant.	Capital at 5 per cent.	Fuel Weight.	Fuel Cost.	Stores Labour.	Maintenance, Repairs, Depreciation.	Total Annual Cost.
	£	Tons.	£	£	£	£
Non-condensing Steam Plant	125	1,022	920	150	250	1,445
Condensing Steam Plant	120	607	546	150	240	1,056
Overtype Superheated Condensing Steam Plant	122	415	373	140	244	879
Gas Engine Pressure Producer	167	305	275	220	334	996
Gas Engine Suction Producer	147	282	395	170	294	1,006
Oil Engine	150	193	405	200	300	1,055
Diesel Engine	160	120	252	200	320	932

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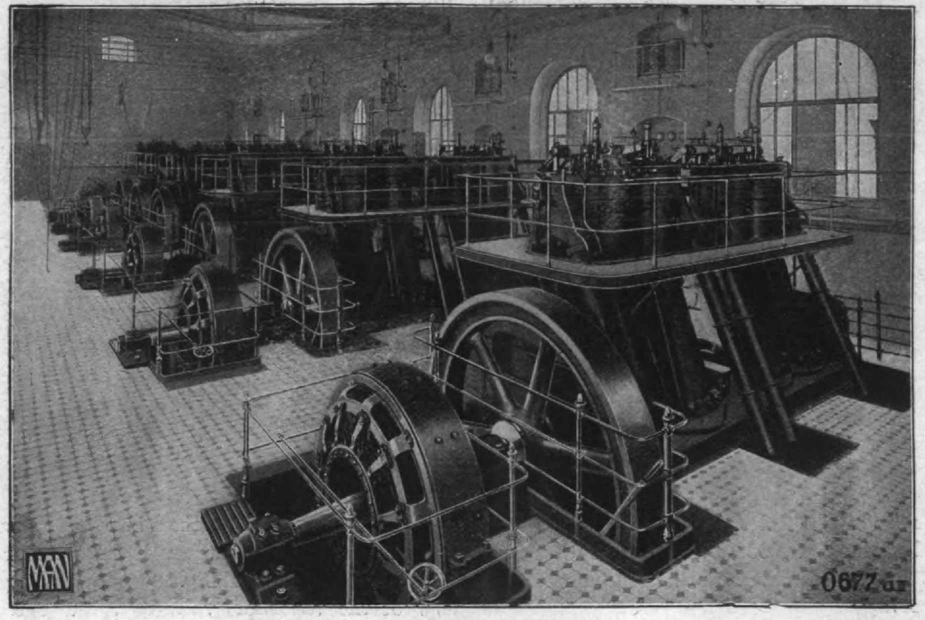

Fig. 50.

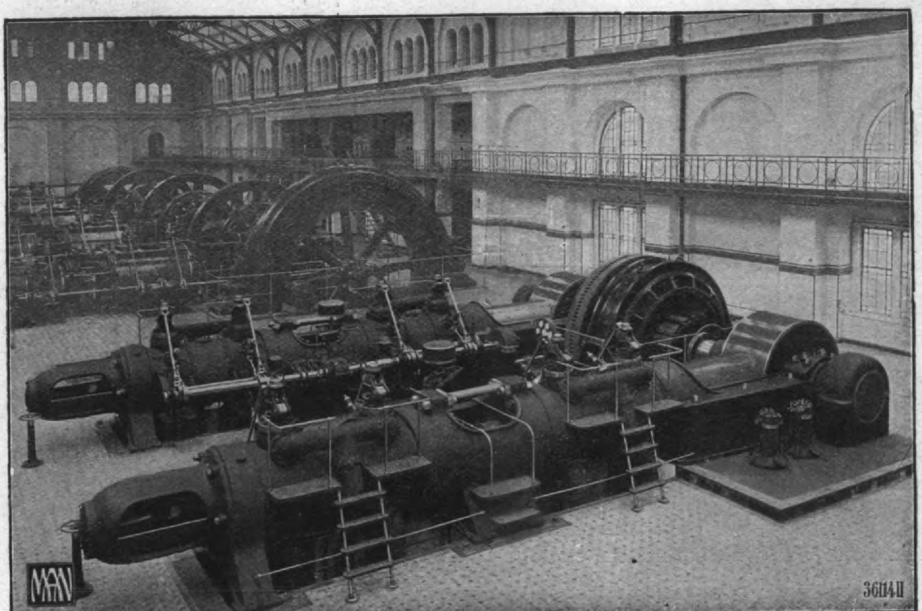

Fig. 51.

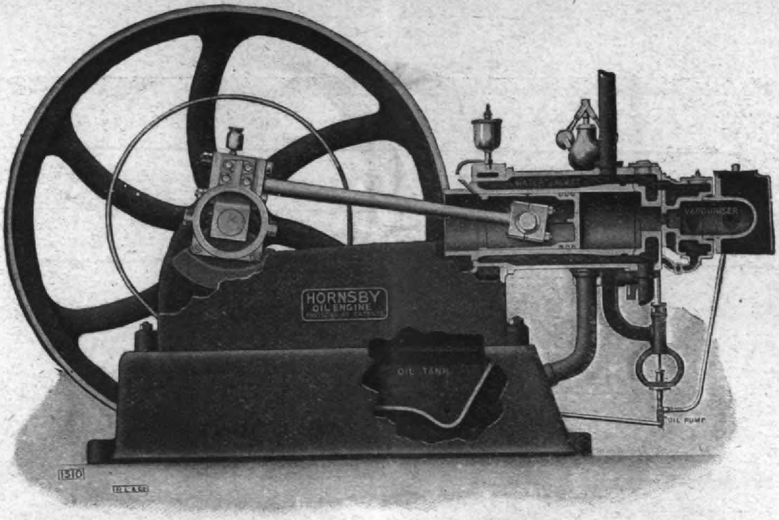

FIG. 52.

driven by horizontal two-stroke double-acting Diesel engines of 2,000 B.H.P., in both cases made by the Maschinenfabrik Augsburg-Nürnberg Co.

VARIOUS HEAVY OIL ENGINES.

The preceding remarks refer principally to Diesel engines. There are many other heavy oil engines on the market, both of the explosion and of the combustion type, and the following have been selected as being representative of the various types :—

The Hornsby-Ackroyd engine is one of the earliest of the explosion engines, and it is understood that some 40,000 of them have been made. Fig. 52 shows a section through the cylinder of one of these engines, and Fig. 53 gives an enlarged view of the vaporiser valve-box. The relief valve is regulated by the governor; the oil pipe delivers a constant amount per stroke, and the amount not required to deal with the load flows back into the tank through the relief valve. The compression has to be adjusted to suit the oil in use; the most usual oil for these engines is Russian oil of a specific gravity of 0·823 to 0·825, but they also work satisfactorily with Texas oil of 0·933 sp. gr. The oil consumption is stated to be 0·674 lb. of Texas oil. These

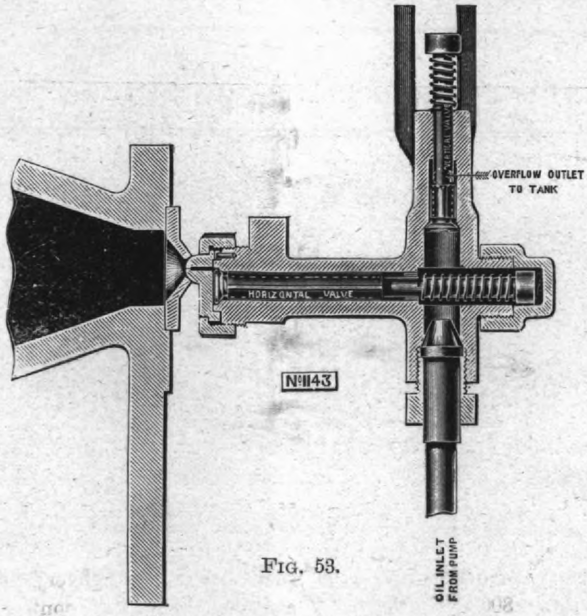

FIG. 53.

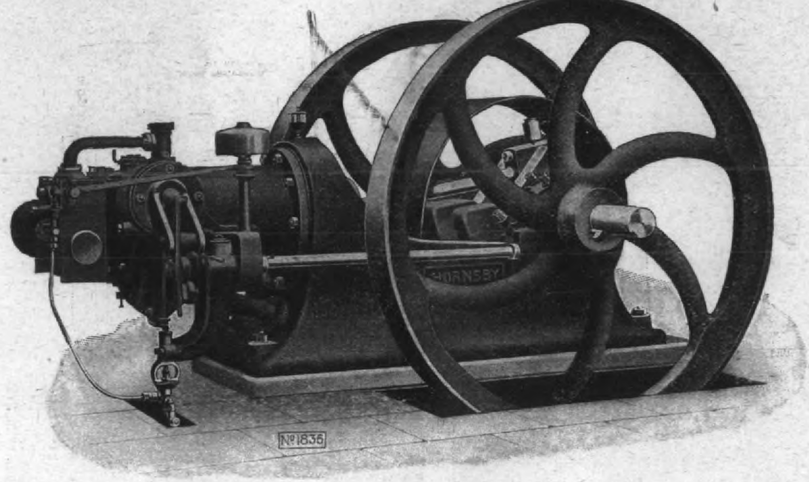

Fig. 54.

engines are listed to about 370 B.H.P., and Fig. 54 gives an outside view.

The Allen engine is shown in Figs. 55 and 56. It is an explosion engine with a hot-pot vaporiser; a blow-lamp is used for heating the hot-pot for starting, or the engine may be started on petrol. The ignition is also ensured by a magneto, and through the valve pocket. As the piston nears the top of its stroke the supply through the valve pocket is cut off and a charge of air at 150 lbs. pressure is trapped in this valve pocket. The fuel is injected at the top of the stroke in a fine spray by means of the special pump, a section of which is given in Fig. 59. There are two

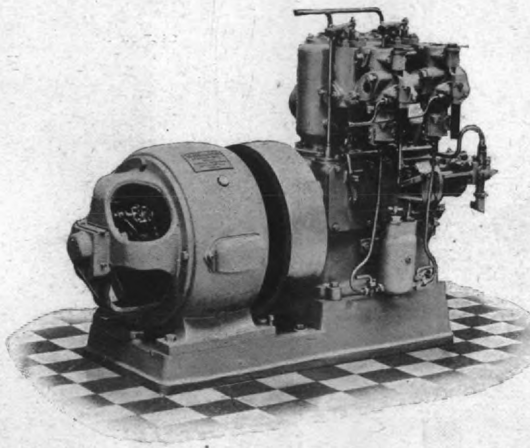

Fig. 55.

these engines use paraffin oil of 0·82 sp. gr., and are built from 2½ B.H.P. at 800 revolutions to 75 B.H.P. at 500 revolutions.

The Cross engine, built by the Westinghouse Brake Co., is shown in Figs. 57 and 58. As will be seen, it has a divided combustion chamber, and there are two air inlets, one through the combustion chamber and a second suction and two delivery valves driven by a cam and under the control of the governor. The fuel injected into the hot compression chamber ignites, no matter how small the load may be, and on the piston descending the air charge trapped in the valve pocket completes the combustion. The hot bulb is of small size, and only requires about three minutes to heat

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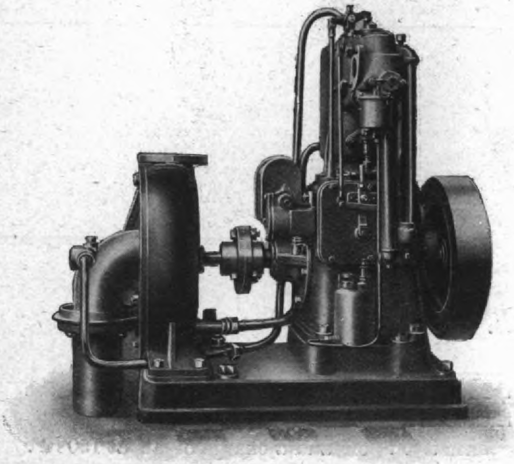
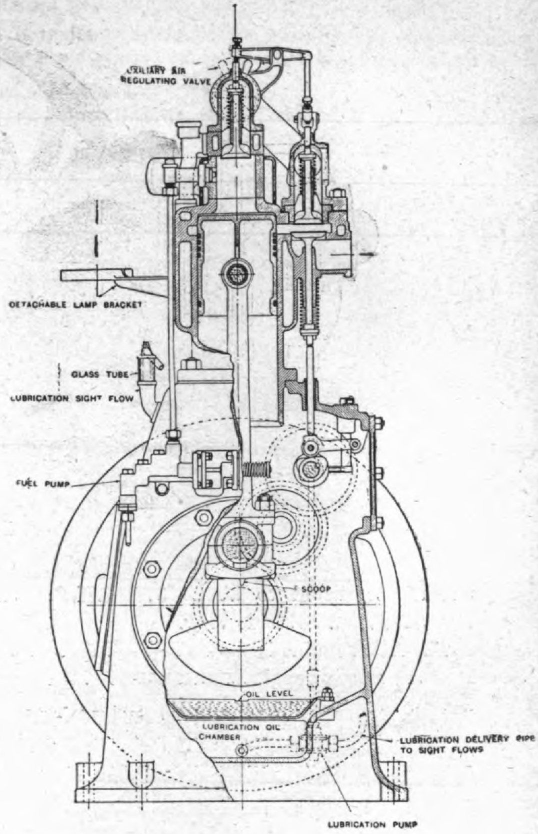


FIG. 56.



SECTION OF 10 H.P. CROSS OIL ENGINE

FIG. 57.

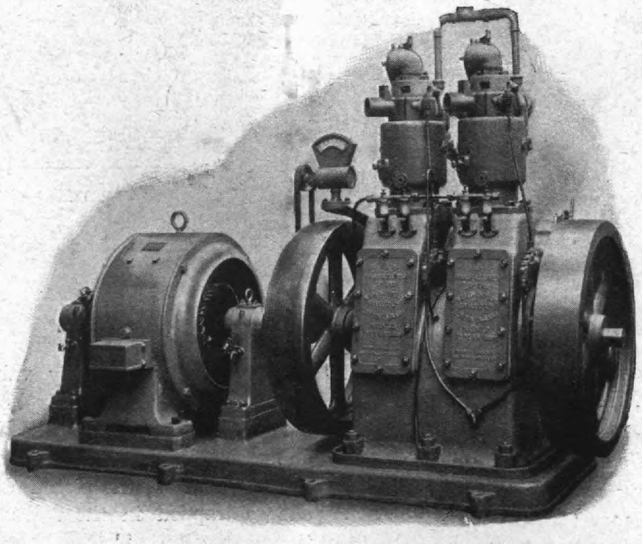


FIG. 58.

it by a blow-lamp. These engines are built up to about 40 h.p. in four lines (illustrated by several slides). The specific gravity of the oil used is 0·85. In this engine it is probable that a portion of the oil is exploded, followed by combustion. The engine may therefore be said to be partially of the explosion and partially of the combustion type, or, as they are sometimes called, of the semi-Diesel type.

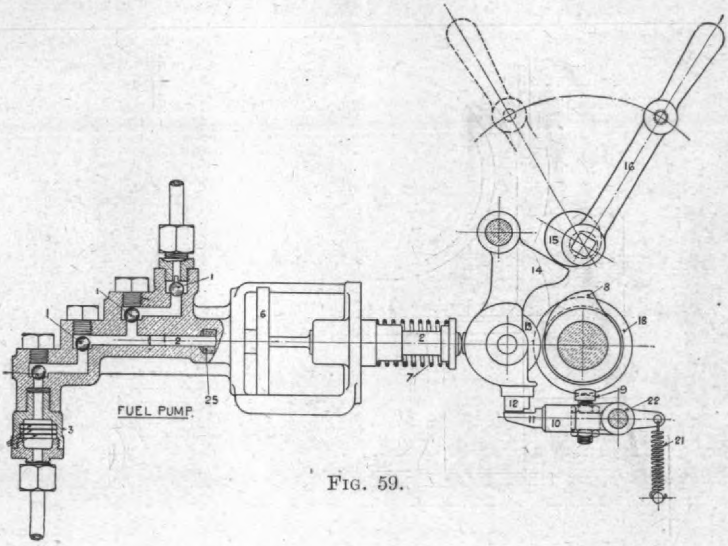


FIG. 59.

The Ruston - Proctor engine is shown in Figs. 60, 61 and 62, the last of which gives a section through the cylinder breach. Like the Diesel engine, it compresses pure air, but the compression, which is from 270 lbs. to 280 lbs. per square inch, produces a temperature insufficient to ignite the oil, and the necessary temperature has to be obtained by the addition of a hot bulb. This engine is, therefore, also of the so-called semi-Diesel type. The hot bulb is heated by a lamp to a dull red before starting, an

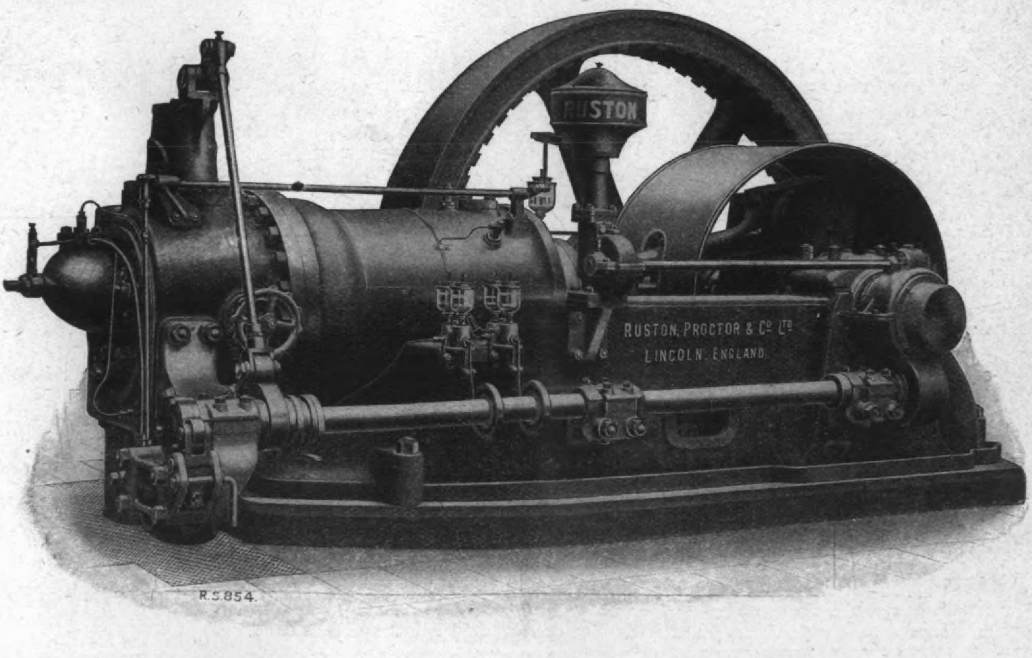


FIG. 60.

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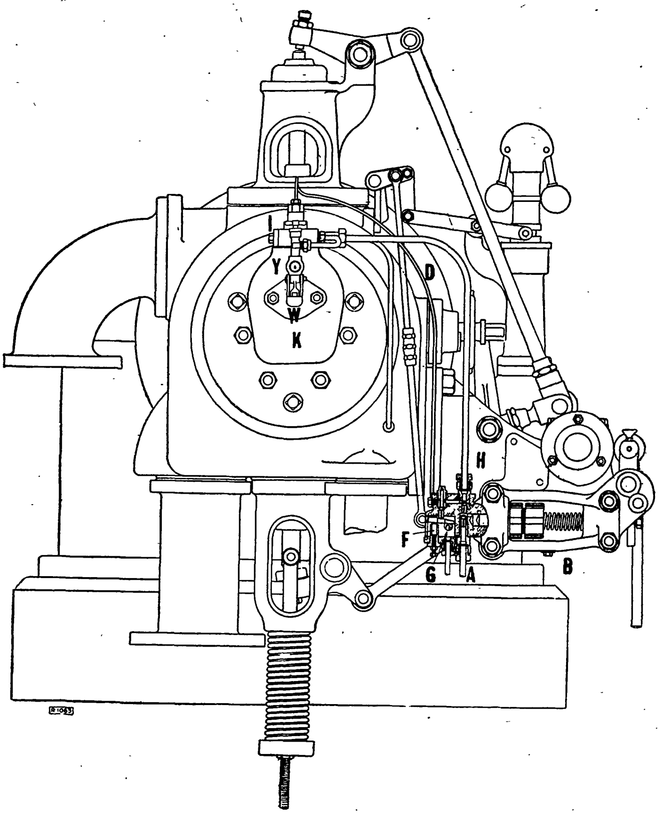

Fig. 61.

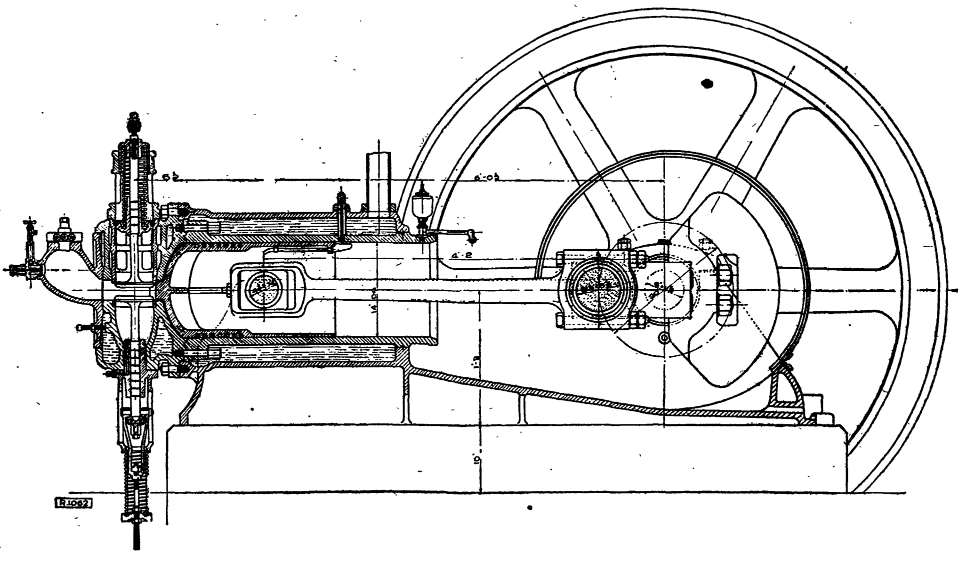

Fig. 62.

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operation which requires about twenty minutes, and it is maintained at this temperature during running by a water injection. The mean pressures obtainable are 84 lbs. with crude oil, and 80 lbs. with Italian refuse. The oil consumption is 0·45 lbs. and 0·49 lbs. per B.H.P. hour respectively, according to test made by Professor Robinson on a 50 B.H.P. engine. A speciality of this engine is the way in which the fuel is injected: a needle valve is lifted by the action of the pressure produced by the oil fuel pump, and a swirling motion is given to the oil by means of a special device. The governor actuates a by-pass which opens the instant the necessary fuel has been injected, thus reducing the pressure and causing the needle valve to drop and shut off the oil.

The Petter engine is a two-stroke engine of the semi-Diesel type. The scavenging air is compressed in the closed crank-chamber on the down stroke of the piston. This air clears out the exhaust products, and on the up stroke pure air is compressed to a moderate pressure and the fuel oil is injected by a pump, and by a special arrangement is intimately mixed with the compressed air.

[One of these atomisers was exhibited and explained at the lecture.]

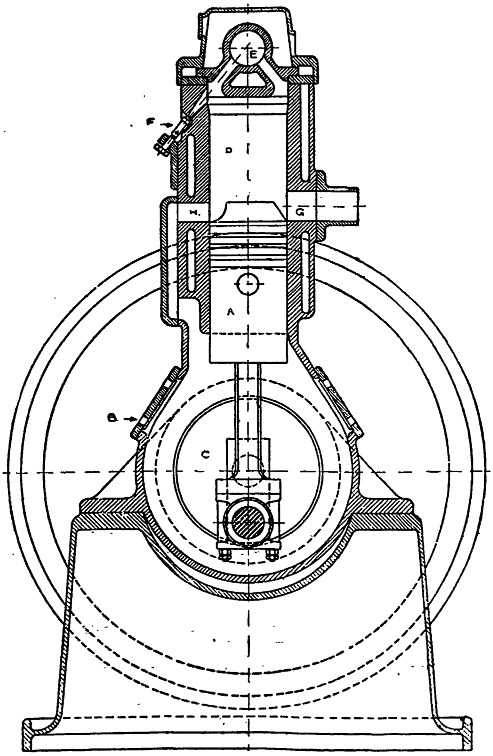

Fig. 63.

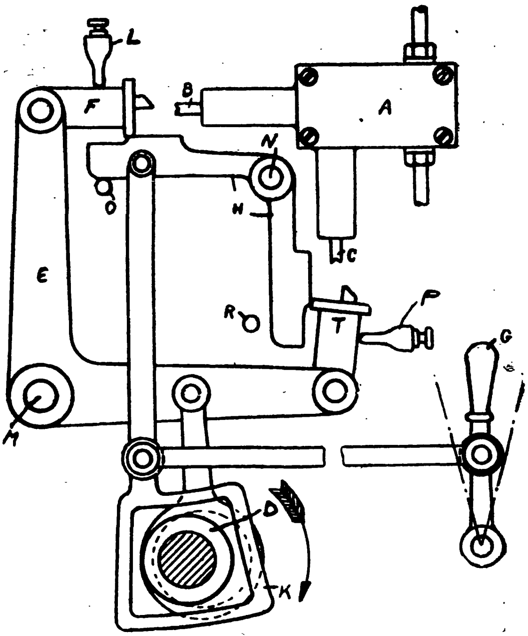

Fig. 64.

These engines work with "fuel" oil of 0·93 sp. gr., and the consumption of oil of 0·93 sp. gr. is stated to be 0·47 lb. per B.H.P. hour.

The Bolinder engine is of the explosion-combustion type; the makers, like many others, object to the name "semi-Diesel." Its action will be easily realised from Fig. 63. Just before the bottom of the stroke the exhaust valve, *G*, is uncovered, and almost immediately after the port, *H*, opens and admits the scavenging air compressed in the closed crank chamber by the descending piston which sweeps out the remaining products of combustion. By the special shape given to the top of the piston, this air finds its way into the hot-pot, *E*, to clear out the exhaust products there. These engines are made in from one to four lines, and from 5 to 320 B.H.P. The consumption of Scotch shale oil varies from 1 lb. to 0·6 lb. per B.H.P. hour, according to the size of the engine. At heavy loads water is injected into the hot-pot to prevent it getting too hot, and thus "cracking" the oil. These engines are principally intended for the propulsion of small ships, such as fishing vessels, etc., and very large numbers have been supplied for these purposes. The reversal of the engine is effected by means of an apparatus diagrammatically shown in Fig. 64. There are two fuel pumps, the plungers of which are marked *B* and *C* respectively; *A* is the fuel pump; *B* is the normal pump worked by the

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pecker *F*, actuated as shown in the figure. The full pump supply only comes into action when the direction of rotation of the engine is to be changed either from ahead to astern, or from astern to ahead. To change the direction of the engine from that shown by the arrow, the lever, *G*, is pulled over to the right; this brings the link, *K*, into contact with the friction wheel, *D*, and by means of the mechanism shown puts the

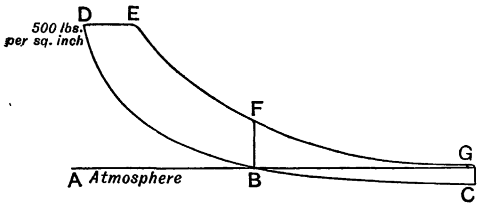

Fig. 65.

pecker, *F*, out of action, bringing pecker, *T*, into action. The pump, *C*, is so timed as to inject the charge of oil before the piston reaches the top of the stroke; this checks the up stroke and drives the piston down in the reverse direction.

An engine has recently been proposed by Mr. Durtnall, which is of the Diesel type, but the suction valve is arranged to close before the end of the out stroke, so that, as shown in Fig. 65, pure air is drawn in from *A* to *B*, and this air is expanded along the line *BC* to the end of the stroke at *G*. The reduction in pressure at the end of the stroke acts as an air cushion, arresting the motion of the parts and reducing the bearing pressure. On compression of the stroke the indicated diagram follows the line *CBD*, and the compression space in the cylinder can be so arranged that the pressure at *D* shall be 500 lbs. per square inch needed for heavy oil ignition. *DE* shows the full admission as in a Diesel engine, and the expansion *EFG* is extended to atmospheric pressure. The exhaust of this engine would therefore be at constant pressure. *BDEFB* would be the diagram of the corresponding Diesel engine. The theoretical thermal efficiency of this type of engine would therefore be greater than that of the pure Diesel engine.

In conclusion, the following chart is given, discriminating between the various types of light and heavy oil engines.

OIL ENGINES.

Heat Admission at

Constant Volume.	Constant Pressure.	Partly Constant Volume and Pressure.
Explosive mixture is produced by vaporisation of the oil either at atmospheric temperature (light oils) or at a higher temperature (heavy oils).	Pure air is compressed in the cylinder, and the oil is introduced just before the turn of the stroke.	
Compressed in the cylinder prior to explosion by a hot tube or bulb, or by an electric spark.	Ignition is caused by the temperature of the compressed air.	Ignition is caused by the oil striking against a hot surface.
Compression limited upwards to avoid pre-ignition.	Compression limited downwards to ensure ignition.	Compression unlimited over considerable range.
Low Compression.	High Compression.	Medium Compression.
80 lbs. per square inch.	500 lbs. per square inch.	200 lbs. per square inch.
Sp. Gr. 0·68 to 0·72 | 0·82	Up to 1·2.	Up to 0·9.
< LIGHT OIL ENGINES > | < HEAVY	OIL	ENGINES. >

THE FOREIGN TRADE OF CHINA, 1911.

The statistics of the foreign trade of China in 1911 not only show but little trace of the general upheaval caused by last year's revolution but constitute a record, exceeding as they did the figures for 1910, which were 11½ per cent. more than in any previous year. Considering the vast extent of the country, and the commercial aptitude of its enormous population, the foreign trade of China, which amounts to about the same value as that of Switzerland, may be said to be still in its infancy. At the end of 1910 there was a financial crisis in Shanghai, the commercial metropolis, resulting from wild speculation in rubber and from the breakdown of the native banking system. The Yangtze River rose to unprecedented heights, and vast tracts of country were inundated, rendering millions of people homeless and destitute. Serious summer floods occurred also in Chekiang, in Shantung, and in the Liao River valley in Manchuria. In August fresh trouble was caused by delays in deliveries of goods due to labour strikes in the United Kingdom, whereby clearances were retarded, and when this trouble was righting itself, the wealthy province of Szechuan, where the crops were excellent, was cut off as a customer by the widespread agitation against the central government's railway policy, which was the forerunner of the October revolution.

This revolution, though its effects were not fully perceptible in the customs statistics for 1911, nevertheless inflicted a crushing blow on the trade of China. From the date of the revolt of Wuchang on October 10th the whole banking system of China broke down, and it was to this financial crisis rather than to the revolution itself that the complete stagnation of trade at the end of the year must be mainly attributed. By the time that the weaker banks were eliminated, and the financial horizon in Shanghai began to clear, the country everywhere had become so unsettled that neither goods nor money could be moved freely.

In the Canton province piracy and brigandage materially affected the supplies to consuming and distributing markets, and though of course the circumstances varied in different provinces up to the end of the year, the conditions were nowhere normal. The establishment of a republican government has opened up a prospect of settled conditions and revived trade, and, given the restoration of order in the interior, commerce will no doubt quickly respond. The general feeling, however, amongst merchants in China seems to be that anything in the nature of a boom is not only unlikely but undesirable, for experience shows that reaction is the almost invariable sequence, whereas if conditions become normal trade will develop gradually and healthily.

The chief articles of import into China admit of being classified into few prominent heads. Opium, formerly so important, is now diminishing rapidly, owing to the agreements between the Indian and Chinese Governments, the latest of these compacts having provided for the complete extinction of the export in 1917, or at an earlier date, if clear proof be given of the complete absence of production of native opium in China. The following table of imports of plain cottons, *i.e.*, shirtings, sheetings, drills, jeans and T-cloths, indicates the share taken by the chief manufacturing countries during the last five years:—

Nationality.	1907 Pieces.	1908 Pieces.	1909 Pieces.
British . . .	8,224,951	8,993,534	10,691,448
United States .	578,647	1,586,989	3,856,231
Japanese . .	840,401	986,982	1,396,297
Indian . . .	67,905	141,312	133,855

Nationality.	1910 Pieces.	1911 Pieces.
British	6,551,126	11,317,630
United States	1,385,819	1,988,061
Japanese	2,389,693	2,832,625
Indian	147,952	21,935

From the above it will be seen that British goods show a still larger and gratifying development, the increase in British jeans at Newchwang in substitution of the American imports being specially noticeable. But the most salient feature of the cotton trade in 1911 was the decrease in the imports of Indian and Japanese cotton yarn to 248 million lbs. in 1911 as against 304 million lbs. in 1910.

Cigarette smoking, which has led to such enormous imports into India, has had to encounter in China an agitation carried on with varying success in Shantung, Kiangsu, Chekiang, Szechuan, Yunnan, and other provinces for the suppression of the practice of smoking. This repressive movement has been encouraged, curiously enough, by the Protestant missionaries, as well as by the Chinese themselves, the latter apparently through dislike of consuming foreign products. The anti-cigarette campaign seems to have been most active in Hangchow, but to have failed in Nanking. At Cheng-tu, the capital of Szechuan, the determined opposition of British and American missionaries was more than counterbalanced by the increased sales of cigarettes to Chinese soldiers there ever since the revolutionary troubles in September.

Another effect has been the signs of revolution in Chinese dress, and an enormously increased demand for foreign hats and caps, and to a lesser extent for foreign boots and shoes, foreign hosiery and underclothing, and even foreign suits of clothes. In spite, however, of the remarkable changes of

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fashion which meet the eye, and which are certain to go on increasing, these will nevertheless fail to be adopted by the mass of the population. The trade in artificial indigo continues to develop, especially in Hunan, where it was formerly unknown, and it has almost displaced vegetable indigo in Chinese dye-works in Manchuria. The business is entirely in the hands of German firms. American flour has been imported in largely increased quantities, especially at Chefoo, this being attributed to the failure of Chinese harvests from floods or other disasters. In machinery, railway material, vehicles, etc., business was dull throughout the year. The figures for kerosene oil again showed an enormous increase, this increase being most marked in American oil, which rose over 50 per cent.

The total value of exports in 1911 fell short of that of 1910 by less than £500,000, but there is no doubt that had it not been for the revolution the export trade of 1911 would have far exceeded any previous record. In value, silk products head the list with a percentage of nearly 25 per cent. of the total, the other chief exports being tea, beans and bean cake, raw cotton, skins, hides and furs, seeds (sesamum) and vegetable oils.

With regard to the shipping trade, one noteworthy feature is the rapid development of the homeward trade from the German port of Tsingtau, which during the past year has become a regular calling port for all the principal Europe-bound lines. The coasting trade, in which British capital and enterprise are still largely predominant, between Shanghai and the Yangtze and northern ports is said to have been until the revolution started in a more flourishing condition than for some years past. On the Yangtze the allied steamship companies (two British and one Chinese) have still to face a serious competition from Japanese lines, heavily subsidised by the Japanese Government, but the French company which for several years ran three steamers between Shanghai and Hankow withdrew last year from the field, their steamers being purchased by the two British companies.

In the domain of railway construction three events of interest are recorded, viz., the opening to traffic of the Kanton-Kowloon railway, the completion of the reconstruction by the Japanese of the railway from Mukden to Antung, and opening to traffic of the same, so that trains can run through over the Yalu bridge to Seoul and Fusan, and the practical completion of the lengthy line from Tientsin to Pukow, on the Yangtze opposite Nanking. The only gap on this line was caused by the delay in the bridge over the Yellow River, but it is hoped it will be completed in the autumn of 1912.

No marked development in the coal-mining industry in China took place in 1911, though each of the principal mines in the north showed an increased output. Many plans have been made and sent in for working the rich mineral deposits of Hunan Province, mainly copper, tin and gold, but, as is well known, Hunan is an anti-foreign province, and the objection to the use of foreign capital is apparently very deep-rooted there.

The record of fresh industrial enterprises established in China during the year is very interesting, including electric light installations, candle, bricks, cement, match and many other factories, a proof of the widespread wish throughout the country to enable native manufacturers to compete successfully with goods imported from abroad.

ARTESIAN WELLS.

In connection with the subject of the artesian well at the Institution of Civil Engineers, described in the *Journal* of the 11th inst., it may be of interest to mention that from time to time a number of deep artesian wells have been sunk in different parts of the metropolis many years back in the last century, notably in the case of the Bank of England, 334 ft. deep (1852), Trafalgar Square fountain, 396 ft. deep (1847), Meux' Brewery, Tottenham Court Road, 360 ft. deep (1843), subsequently deepened to 1,144 ft. in 1876, the Victoria railway station, 360 ft. deep (1861), and a good number of breweries, distilleries, and large manufactories. These consisted of deep shafts first sunk into the London clay, from the bottom of which boreholes were made into the chalk, whence the water flowed up into the shaft.

It is, however, more particularly of late years, during which the shafts have been dispensed with and replaced by the more economical bored-tube wells, that a considerable increase in the number of artesian wells has been made for public baths, electric generating stations, and other purposes, including, more recently, tube railway stations and tramway depots, and numerous establishments besides manufactories, such as the offices of large commercial firms, extensive blocks of city offices and residential flats, etc.

Amongst these a few may be mentioned, such as the wells for the Central London tube railway at Shepherd's Bush, 380 ft. deep, the metropolitan public baths of St. Pancras, 400 ft. deep, the Borough of Bethnal Green public baths, 500 ft. deep, the London County Council tramway depot at Greenwich, 350 ft. deep, the Borough of Hackney electric generating station, 450 ft. deep, City office buildings in Mincing Lane, Gracechurch Street, Lombard Street, and London Wall, the Norwich Union Life Assurance offices, St. James's Street, the Anglo-American Oil Company's offices, Queen Anne's Gate, and the Amalgamated Press offices, Farringdon Street, of various depths ranging from 400 to 500 ft. deep; also residential flats in Ashley Gardens, Victoria Street, S.W.

The depth at which the chalk is reached varies considerably, ranging from 82 ft. at Hackney and 105 ft. at Greenwich, and 161 ft. at St. Pancras to 234 ft. at Queen Anne's Gate, and 256 ft. at Ashley Gardens.

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The quantity of water yielded also differs considerably, according to the district, the porosity of the chalk at the site, and the capacity of the pump employed, and may range from 5,000 gallons to 50,000 or 80,000 gallons per diem.

[The above information has been furnished by Mr. Alfred Le Grand, of the firm of Messrs. Le Grand & Sutcliff, who carried out the work at the Institution of Civil Engineers.]

THE MANGROVE INDUSTRY OF MADAGASCAR.

The production of red mangrove bark in appreciable quantities for export in Madagascar has considerably developed since 1905. In that year the quantity exported was only about 137 tons, valued at £450, while for the year 1910 the figures were 36,131 tons, valued at about £106,000. The mangrove forests are in the Provinces of Nossi-Bé, Analalava and Majunga, on the north-west coast of the island, bordering on the Mozambique Channel. In the first two provinces the approximate areas of mangrove trees amount to about 80,000 and 49,000 acres respectively. On account of the density at certain points in Majunga, it has been impossible to ascertain, even approximately, the area of the mangrove forests in that province. It is believed, however, that the total area of mangrove trees in the three provinces is between 75,000 and 100,000 hectares (185,000 to 247,000 acres). The mangrove trees are generally grouped at the mouths and on the banks of the numerous rivers, and at the ends of the numerous bays in the three provinces mentioned. Quantities of trees are also found along the immediate coast, and in some instances, especially in the Province of Analalava, they extend more than six hundred feet into the sea, their working being facilitated by the fall of the tide. In most of the bays, and in several of the largest rivers, steamers enter to receive the bark. The average size of the mangrove tree is from 20 to 40 inches in circumference and 100 feet in height. The above figures and estimates, as regards area and density, relate to mangrove trees in general, of which there are several species, only two being useful for tanning purposes, the *anabovahatra* and the *tsitolony*. The proportion of these to the total area of mangrove trees is unknown. The *anabovahatra* is said to contain 60 per cent. of tannin, and the *tsitolony* only 30 per cent. The latter, because of its inferiority, has been worked very little, owing to the fact that there has always been an abundance of the former. The *anabovahatra* is also much used for construction timber. It is said that the heart of the tree is equivalent in quality and durability to the "teze," a very hard and substantial wood coming from the Madagascar forests. According to the American Consul at Tamatave, there are four or five other species of mangrove trees being worked for various purposes. By the public service the mangrove wood is used for general construction and building, and for bridges; by the natives for house-building and making household utensils, such as dishes, plates, spoons, etc., and in commerce it is sold both wholesale and retail, sometimes being exported as far as India for use in boat-building. It is estimated that by working the *tsitolony* bark the present production can be continued for four or five years, when it is expected that there will be a decline for an equal number of years, after which the *anabovahatra* bark, which is said to be getting scarce, will again be in a full state of production. It takes about ten years for a mangrove tree to arrive at an exploitable stage. Mangrove trees of all kinds are worked for bark and other purposes under permits obtained from the chief of the district in which the work is to be done. Concessions may be obtained by all solvent persons approved by the Governor-General. The labourers employed in the industry are chiefly Indians, with a few Europeans and Creoles, who obtain the necessary permits and employ the natives to gather the bark. The product is controlled by a few large firms at the ports of Majunga, Nossi-Bé, and Analalava, which not only purchase nearly the entire output of bark, but furnish money to many of the workers. Practically all the bark is shipped to Hamburg in British and German ships.

THE CULTIVATION OF RICE IN SIAM.

More than forty varieties of rice are cultivated in Siam. The "hill" rice is a peculiar variety planted on the hillsides in Northern Siam, and is said to be marvellously productive. When ripe the ears of this rice are black, but when husked and boiled the grains are of a reddish colour, and have a peculiar fragrance. The "glutinous" rice is another variety, grown in the mountain valleys of Northern Siam, and forms the main food for the people of those regions, while white rice only is grown and used by the people on the plains of Lower Siam. A common kind of rice cultivated on land liable to floods during the rains, is said to grow as much as a foot in twelve hours, so that the plant often attains a height of ten feet in its efforts to keep its leaves above water. The rice commonly grown in Siam consists of the so-called light crop, which is planted on irrigated land, often as early as February, and reaped in May or June, and the heavy crop, which is planted between July and September and harvested in December and January. A prominent Siamese rice grower gives the following description of the rice supplied for export. Rice that is exported can be roughly divided into three classes—Na Muang, Pasak, and garden rice. Na Muang is the cheapest quality, and is grown chiefly in the district of Ayuthia. The grains are short and have a great deal of red rice mixed with them, and they are also very much cracked, and therefore liable to be broken in milling. Pasak rice, which is of better quality than Na Muang, comes from the Pasak River district, and is

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a variety of golden rice. It is only due to the soil of this district that it is of poorer quality than the ordinary garden rice. The so-called garden rice forms the main bulk of rice that is exported, and is of the best quality. Na Muang and Pasak rice are used for mixing with it. This rice was formerly grown in the ditches of vegetable gardens, but is now grown on vast tracts of land, both by broadcast sowing and transplanting processes, so that the name garden has lost its original meaning. On account of the exhibitions of rice during the last three years, very fine varieties have been brought to the notice of cultivators. Many of the varieties exhibited are considered by experts to be among the best in the world.

ARTS AND CRAFTS.

Glass (*English and Foreign*). — Though the making of cameo glass goes back at least to the period which produced the Portland vase, it was not until the Paris Exhibition of 1900, when certain French and German craftsmen showed some very interesting and wonderful examples of this kind of work, that much had been heard about it in modern times. Since that date it has not died out, but seems to have grown more and more popular, at any rate in France. The French exhibits at recent International exhibitions have generally included a collection, sometimes a large collection, of glass treated in this way, and some very fine examples were to be seen a couple of years ago at the Brussels Exhibition. Specimens of it are habitually shown in the best Paris glass and china shops, mostly with a neat little label giving the name of the maker, and it has come to be a well-known branch of French artistic craftsmanship. Indeed, by this time it is so much in demand abroad that it is being fairly extensively imitated in a way which threatens to cheapen something which at its best is really beautiful. The work of Gallé, Daum, and others, is too well known to need description, and its method—the laborious cutting away of one or more layers of glass in places leaving a pattern standing (in a corresponding number of colours) on a ground of yet another tint—makes it necessarily expensive. The cheap version of such delicate workmanship leaves a great deal to be desired, and yet is sufficiently reminiscent of the genuine thing to bring it into disrepute. It is noticeable that the glass used in this modern Continental cameo work is mainly of a semi-opaque kind, which, although when artistically manipulated it gives beautiful colour effects, is very unpleasant both in tint and texture in the commoner versions. Moreover, wonderful as the best French cameo glass undoubtedly is, it is not pre-eminently glass-like, just as certain glass tiles, though they are plainly vitreous, give one the impression of being not quite glass. It may be this peculiar quality in the material which has prevented this kind of glass from becoming as popular in England as on the Continent; it may be simply that the British public is not prepared to pay the price which the good work demands, and will not be content with the bad. However that may be, we have seen comparatively little cameo glass in England, and until recently the English makers do not appear to have done anything with it. Now, however, Messrs. James Powell & Sons have produced a few pieces which are really fine. They differ from the Continental work in two important respects—the underneath layer of glass (that which forms the vase itself), and sometimes also the upper layers, are formed of really clear, transparent glass, and the brilliancy of this is enhanced by the addition of gold leaf applied before the shape is blown to its full size, so that it divides into tiny fragments and leaves flecks of gold on the fully-blown vase. The most interesting piece is a blue vase some ten inches high, ornamented with a pattern of small white blossoms, touched here and there with just a hint of pink. It is a really beautiful piece of work, good in shape and tastefully decorated, and the little final touch of colour is well worth the extra trouble it has involved. Some of the other examples, in which the pattern is in transparent ruby on a paler red ground, though beautiful if seen by themselves and very suggestive, are not quite so satisfying or so subtle as the white on blue. It would seem as though the results were more satisfactory when the upper coats of glass are less transparent. The pieces are very different from the French work, and the best of them have a charm and a quality which the foreign productions lack. Besides this particular new departure, Messrs. Powell & Sons are continuing and perfecting other branches of artistic glasswork. The simple Roman cutting which they began to imitate so successfully some years ago is still being used, and they are now adapting it with success to present-day uses, as a dessert-service of a quite modern type entirely decorated with this type of cutting shows. Some of the copies of old Waterford, although, of course, executed in a more usually accepted style of cutting, are also very interesting. The number of reproductions and adaptations of old vases found in Crete and elsewhere is being steadily added to, and the translation of vessels made originally by rather primitive pottery methods into glass provides an opportunity for using a thick engraved line, which forms a very effective contrast to the clear glass, and one for which there is no scope in the more everyday types of vases. Not the least of the beauties of these objects is that they are so absolutely glasslike. There is nothing, in spite of the clay prototypes which gave the first hint of some of them, to suggest any other material or to make one feel that any of them could have been executed more satisfactorily in pottery or carved stone.

Quilts and Quilting.—Heartily as certain doctors may dislike them, eiderdown quilts are nowadays almost as necessary an accompaniment of a bed as are counterpanes—or bedspreads as we are are learning to call them. The time has long passed

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when it was looked upon as inevitable that these quilts should be covered with a cotton material, gaudily printed with an adaptation of an Indian or Persian pattern. It has been for years the custom to encase the down in silks or sateens of pretty and harmonious colours, sometimes plain, more often patterned, which either match or tone in with the hangings and covers of the bedroom. Various experiments, more or less successful, have also been made in combining plain and patterned stuff on the same quilt; but for the most part the value of the quilting itself as a means of obtaining pattern has been quite overlooked. This is all the more remarkable, because most people know something of what has been done in the way of quilting in the past. Those who have not wandered far from home are aware that quilting is one of the old-established industries in certain parts of this country. Those who have travelled rather farther afield are familiar with the attractive quilted coverlets (in which the stitching in another colour plays so important a part in the decoration) to be seen hanging out of countless windows any fine morning in Palermo and other towns of Southern Europe. People interested in embroidery all know the wonderful quilt illustrating the history of Tristram and Isolt in the Victoria and Albert Museum; not a thing to be copied nowadays, but a marvellous and beautiful production none the less. It is, however, only recently that manufacturers over here seem to have bethought themselves of the possibility of letting the stitching of the ordinary quilts of commerce form their decoration. They have before been content to let the necessary stitching down of the material take the form of any dull geometric pattern that came to hand. The fashion of using plain instead of patterned materials for decorative purposes has in this particular case, however, led only to the substitution of stitched for printed ornament. The custom of covering quilts with self-coloured material has, it would seem, made people notice the poverty of the plans on which the stitching is based; and this year we find quite a number of fresher and more ambitious patterns being employed. The motifs so far are not very elaborate, but they are a step towards real design, and are sometimes reminiscent of good old quilting patterns. The difference in the materials employed would preclude the production of anything resembling the most elaborate of the old work, even if it fitted in with our modern ideas, but there is no reason against, and every reason for, the introduction of good designs to take the place of lattices, panellings, and other unsatisfactory and rather makeshift plans which used to be in vogue. It is to be hoped, by the way, that the undesirable practice of outlining portions of the pattern in coarse lace, which spoils the proportion of the design and makes the whole thing look like an enlarged pin-cushion of a fussy and most untasteful kind, will not tend to divert into wrong channels something which is otherwise undoubtedly a movement in the right direction.

CORRESPONDENCE.

COLONIAL REPRESENTATIVE GOVERNMENT.

In the *Journal* of the 18th inst., the late Governor of Barbados rightly gives priority to Virginia in representative institutions, by a grant in 1619, one year before the grant to Bermuda. He adds a caution that a grant did not necessarily imply the immediate establishment of parliamentary government. Let us see what happened in Virginia. On April 19th, 1619, Sir George Yeardley (successor to Lord Delaware, deceased) arrived with a new authority under the Charter, by which the powers of the governor were limited by a council, and an annual general assembly, to be composed of the governor and council, and two burgesses from each plantation, to be freely elected by the inhabitants thereof. On July 30th, 1619, in accordance with the Governor's summons in June, the first representative legislative assembly ever held in America was convened in the chancel of the church at James Town, and was composed of twenty-two burgesses from the eleven several towns, plantations, and hundreds, styled boroughs. The proceedings were opened with prayer, and each burgess took the oath of supremacy. A speaker, a clerk, and a sergeant-at-arms were elected. The education and religious instruction of the children of the natives was enjoined upon each settlement. Tobacco was authorised as a currency. The government of ministers was prescribed according to the Church of England, and a tax of tobacco levied for their support. It was also enacted that "all persons whatsoever, upon the Sabbath days, shall frequent divine service and sermons both forenoon and afternoon."

Thus in Virginia representative institutions took effect without delay. Just a month after the meeting of the first assembly, in "August, 1619, came in a Dutch man-of-warre that sold us twenty Negars," and so began negro slavery. In the same year there were sent to the colony one hundred disorderly persons or convicts, by order of the king, to be employed as servants. Boys and girls picked up in the streets of London were also sent and bound as apprentices.

My authority is the "History of America," edited by Justin Winsor, librarian of Harvard University. The proceedings of this early assembly are not beyond criticism, but allowances must be made—they occurred a long time ago, and the Colony had not learned to prosper.

William Latham.

GENERAL NOTES.

The Salt Industry of Honduras.—Choluteca and Valle furnish most of the salt used in the interior of Southern Honduras. There are two methods of making salt—sometimes the sea-water

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is used and sometimes the ground along the beach. In the first case the water is gathered in vats built in the ground, where it remains twenty days. It is then placed in earthen vessels and boiled until the process of evaporation has been completed. In some cases iron pans six feet long and wide and thirteen inches deep are used instead of the native vessels called "hoyas." After the earthen vessels have been used a number of times, a part of the salt has accumulated in the form of a hard lump, and adheres to the bottom of the vessel. This hard salt can be got out only by breaking the vessel. It is called "curuma," and is used in food for cattle. Where iron pans are used, the furnace is sometimes provided with two chimneys, and, when large enough to heat two or three pans, it has several divisions to prevent all the heat being drawn into the back part of the furnace. The water is boiled eleven hours, the salt taken out, and the process renewed. One iron pan produces 700 lbs. When the ground itself is used, a part of the beach is ploughed up with an implement having a number of prongs, and allowed to dry in the sun. It is placed in troughs made from the trunks of trees, twenty-one to twenty-four feet long, mixed with salt water, and filtered through straw into a small trough that carries the water to a second large one, several feet lower than the first. Here it is weighed to determine the amount of salt, and then evaporated as in the first method.

The Glove Industry of Grenoble.—According to the latest statistics there are about three thousand men and women employed in the glove factories of Grenoble, and about twenty thousand more work in their homes in that city and its vicinity. The yearly production of gloves is about 1,500,000 dozen pairs, valued at £1,875,000. During 1911, the necessity for counteracting foreign competition and recovering lost ground led to the establishment of a special local school of glove-making, as a section of the Vaucauson School. For a number of years the establishment of a national school of this character was under discussion, but the question of expense stood in the way. It is provided that at least ten students shall be graduated each year as experts in the fabrication of gloves, following the regular three or four years' course in this school. These students, through their knowledge of details and general commercial requirements, will be fitted to act as superintendents of glove factories, agents for the sale of gloves, or instructors of others in the same industry. The course of study will include the origin, quality, choice, handling, buying, and preservation of skins, leather dressing, assorting, tanning, dyeing, and pulling; colouring matters and chemical manipulations; cutting, sewing, hand work, machine work, embroidering, finishing, and packing; foreign markets and competition; transportation, tariffs, etc.

Opal Production in Australia.—The mines producing black opals are situated at the head of the River Darling, New South Wales, about sixty miles from the village of Walgett. They were discovered nearly nine years ago. The output for the first three or four years was very small indeed, only an occasional black stone being found, but some larger finds were subsequently made, and attracted a large number of miners, at one time a thousand or more being at the field. The black opal is confined within very small limits, and the supply has gradually fallen off, until during the last few months the output has been almost nil. Very likely the mines are not exhausted, but the discovery of the new run of stone, difficult at the best of times, will be still more difficult on account of the number of miners being so much reduced. The Australian opal production of all descriptions is now 75 per cent. less than has been known at any other time during the last twenty years, and black opal in particular has temporarily ceased to be produced. In addition to New South Wales, opals are found in the Beechworth district of Victoria, and in Queensland the opaliferous district stretches over a considerable area of the western interior of the State, from Kynuna and Opalton as far down as Cunnamulla.

MEETINGS FOR THE ENSUING WEEK.

Monday, October 28...Architectural Association, 18, Tufton-street, S.W., 7.30 p.m. Mr. L. Weaver, "Small Country Houses of To-day."

Tuesday, October 29...Sociological, at the Royal Society of Arts, John-street, Adelphi, W.C., 8.15 p.m. Dr. W. F. Mott, "Is Insanity on the Increase?"

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. R. Lydekker, (1) "'*Gazella hayi*' = *Gazella fuscifrons*"; (2) "The Bornean Bantin." 2. Mr. E. G. Boulenger, "Notes on the Breeding of the 'Millions' Fish (*Girardinus pœciloides*)." 3. Rev. T. R. R. Stebbing, "On the Crustacea Isopoda of the 'Porcupine' Expedition." 4. Dr. F. E. Beddard, "Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—VII. On Six Species of Tapeworms from Reptiles belonging to the Genus *Ichthyotœnia* (s. l.)." 5. Mr. E. Dukinfield Jones, "Descriptions of new Butterflies of the Genus *Thecla* from S.E. Brazil."

Wednesday, October 30...Auctioneers' and Estate Agents' Institute, 34, Russell-sq., W.C., 8 p.m. Inaugural Address by the President, Mr. Arthur W. Brackett.

East India Association, Caxton Hall, Westminster, S.W., 4.30 p.m. Mr. R. Grant Brown, "A Common Alphabet for India."

United Service Institution, Whitehall, S.W., 3 p.m. Major C. H. Richardson, "The Employment of War Dogs, with special reference to Tripoli and other recent Campaigns."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. C. H. Bothamley, "The Walled Town of Aigues Mortes."

Thursday, October 31...Child Study, 90, Buckingham Palace-road, S.W., 6.15 p.m. Address by Mrs. Fanny Fern Andrews.

7.30 p.m. Dr. F. H. Hayward, "Statistical Theory for Teacher and Administrator."

China Society, Caxton Hall, Westminster, S.W., 8.30 p.m. Mr. Oliver Bainbridge, "The Heart of China."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. A. H. Blake, "Portugal: Land and People."

Friday, November 1...Engineers, Junior Institution of, 39, Victoria-street, S.W., 8 p.m. Mr. H. P. Philpot, "A Tramp in Switzerland."

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Journal of the Royal Society of Arts.

No. 3,128. VOL. LX.

FRIDAY, NOVEMBER 1, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

OCEAN WAVES, SEA-BEACHES, AND SANDBANKS.

By Vaughan Cornish, D.Sc., F.R.G.S., F.G.S.

Lecture I.—Delivered January 22nd, 1912.

On the Height, Length, and Speed of the Highest Waves finally produced in Deep Sea by a Wind of given Velocity.

In a former paper * I examined the observations of heights of waves in the deep sea as recorded by officers of the French Navy, and showed that the average height of the waves increased proportionally to the increase in the velocity of the wind, so that velocity of wind in statute miles per hour = 2·05 × *average* height of the waves in feet; or, in other words, the average height of the waves in feet was very nearly one-half the velocity of the wind in statute miles per hour.

In a later publication † I gave particulars of the height of the waves in a limited number of storms at sea, in which the waves seemed to have attained their full development, some of the cases being my own observations, others those of observers who had sufficiently recorded the attendant circumstances of position and weather. These heights are, of course, greater than those given by the constant in the above empiric formula, but they are not inconsistent with direct proportionality to the velocity of the wind, using a higher constant, such as 0·7 instead of 0·5.

When preparing the first cited paper—that of 1904—I had examined also the lengths of waves recorded by the French observers, but found that their relation to the velocity of the wind was so variable that I abandoned for the time the attempt to obtain an empiric formula connecting the two quantities. It was apparent that although the waves soon attained, in the open sea, a height not far short of the highest possible, yet the measurements were often made while the growth of length was still far from complete. Conversely, if measurements were made soon after the wind began to decrease, the height of the waves had appreciably diminished, but their length had not.

I have since found that, by restricting the examination of figures to cases where the record of weather and position shows that the wind has had time and opportunity to complete its work, consistent results are obtained connecting the observed speed of the waves with that of the wind. In some of these cases the length of the waves has also been directly observed. The fact that waves driven by the wind have very nearly the same length as those of the same speed travelling by gravitation alone in calm weather is sufficiently established by observation to allow the length to be calculated from the observed speed in the remaining cases, and *vice versâ*. The following records by other observers are among those selected as satisfying all requirements in my book on waves, written before I had hit upon the numerical relation which is the subject of the present lecture. Their selection from among many was, therefore, quite unbiased.

Lieutenant Paris, of the French Navy, in a storm in the Southern Indian Ocean which lasted four days, observed during the first day a wave-length of 371 ft., corresponding to a speed of 30 statute miles per hour, but during the fourth day a length of 771 ft., corresponding to a speed of 43 s.m.p.h. The velocity of the wind was 46 s.m.p.h.; so that during the first day it blew across the ridges of the waves at 46 − 30 = 16 s.m.p.h., but during the last day its excess speed was only 3 s.m.p.h.—*i.e.*, the highest waves were travelling with a speed nearly equal to that

* *Geographical Journal*, May, 1904, "On the Dimensions of Deep-Sea Waves," etc.

† "Waves of the Sea and other Water Waves," by Vaughan Cornish. (Fisher Unwin, 1911.)

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of the wind. Thirty waves were 29·5 ft. high, six were 37·7 ft., and some were higher than this.

In an exceptionally prolonged storm in the Southern Indian Ocean, Captain David, of the s.s. "Corinthic," recorded waves of an average length of 675 ft., with a calculated velocity, therefore, of 40 s.m.p.h., the wind being 44 s.m.p.h.—*i.e.*, with an excess velocity of only 4 s.m.p.h. The heights of the waves ranged from 38 ft. to 45 ft.

The following observations by the Honble. Ralph Abercromby are among those which I have often cited as being some of the most fully described. On the voyage between New Zealand and Cape Horn, on June 10th, 1885, the velocity of the wind was 31 s.m.p.h., rising in some squalls to 37 s.m.p.h. He measured waves of velocity 32, 35, 39·5, and 28·5 s.m.p.h., the average velocity being, therefore, 33·75 s.m.p.h. The lengths of those travelling at 32, 35, and 28·5 s.m.p.h. were measured, and found to be 507 ft., 470 ft., and 358 ft.—average 445 ft. Individul waves were measured with heights of 26 ft., 21 ft., 23·5 ft., and 26 ft., or an average of 24 ft.; but a sensitive aneroid registered a total rise and fall of 35 ft., which I explain by the supposition that there was a swell running with a height of 11 ft. Thus the velocity of the high waves was not less than the average velocity of the wind.

In a storm in the Bay of Biscay on December 21st, 1911, I had the opportunity of seeing large waves in final and regular development. They were produced by a wind which happened to have precisely the same direction as a regular and heavy swell which was already running. The waves rapidly increased in height, speed, and length, until we enjoyed the unusual spectacle of perfectly regular storm-waves with no "swell," no noticeable minor waves, and no crossing of wave-crests. The ship—P. & O. s.s. "Egypt"—was hove-to at about 3.30 A.M., and rode out this storm until about 1 P.M. I observed the waves from 8 A.M. until 1 P.M., both from the promenade deck with an eye-height of 27 ft., and from the captain's bridge with an eye-height of 54 ft. The sun was shining and the weather clear, and every circumstance combined to make observations unusually easy and satisfactory. The ship being held stationary, head on to the waves, the real and the apparent speed of the waves were the same, and the ship's length gave a base of measurement for the distance between two crests viewed simultaneously from the bridge without correction for difference of direction. The ship's length gave the base for calculating the speed from the time of traversing the distance from stem to stern as seen from the bridge, also without correction. This time, combined with the period, gave a second mode of observation of the length.

The period gave also a means of comparing the calculated length with the observed length of a wave. These measurements were made at noon. The agreement is sufficiently good to give me confidence in deducing the length of the waves at 10 A.M. and 8 P.M. from the period then observed. The velocities of the wind are obtained by taking the mean of two sets of estimations :—

	Beaufort's number.		Velocity s.m.p.h.
Wind at 4 a.m. . .	9	10	48·5
„ 8 a.m. . .	9	9/10	46·5
„ noon . . .	8/7	8	35·5

The waves observed were :—

Time.	Period observed.	Length calculated from period.	Length observed by simultaneous crests.	Length observed indirectly.	Speed observed in s.m.p.h.	Speed calculated from period in s.m.p.h.
	Seconds	Feet	Feet	Feet		
8 a.m. . .	13·5	933	—	—	—	47·15
10 a.m. .	12·5	821	—	—	—	43·66
12.15 p.m..	11·27	651	612	708	42·74	39·37

[The above calculations are performed with the precise factors used in the General Formula (see *post*). The figures quoted from my book on "Waves of the Sea" are calculated by a somewhat rougher approximation.]

At 10 A.M., with an eye-height of 27 ft., almost every wave passed considerably above my line of sight, and I estimated this excess of height at 4 ft., which would make them 31 ft. in height. There was a remarkable approach to uniformity in height, the sea differing in this respect from that in which there is a swell running at the same time as the shorter storm-waves. Being occupied with measurements of length and speed, I had not time to make a detailed examination of the heights by seeking different elevations on the ship which would

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place me on a level with the lowest and the highest waves. Judging, however, from the general appearance, coupled with the experience of measurements on former occasions, I should say that there were few waves which differed by more than 5 ft. from the average, which would make the range of height, except in isolated instances, only about one-third of the mean, viz., from 26 ft. to 36 ft.

The above observations show that the highest series of waves—which, indeed, was the only series visible—were travelling at a speed almost if not quite as great as that of the wind by which they were produced.

So much for the speed of the highest waves I have observed at sea during storms. I proceed to describe observations of the period—and, by theoretical calculation, the speed—of the waves which reach the seashore as breakers.

On December 29th, 1898, I observed at Branksome Chine, on the Dorset coast, between Bournemouth and Poole, 139 consecutive breakers with an average period of 19 seconds, and therefore a calculated velocity when in deep water of 66·5 statute miles per hour and a deep-water wave-length of 1,850 ft. There were very strong winds on the Atlantic from December 25th to 29th, 11–12 of Beaufort's scale (64–77 s.m.p.h.) being recorded on ships. On land, 77 s.m.p.h. was recorded at Alnwick, Northumberland, at 10 P.M. on the 27th, and 71 s.m.p.h. at 2 A.M. on the 28th. Waves 45 ft. to 52 ft. high were reported in N. 47° W. 19° on December 29th from s.s. "St. Simon," but I have no details as to how the heights were estimated.

On February 1st, 1899, I observed twelve consecutive breakers at Branksome Chine with an average period of 22·5 seconds, which is the longest period I have ever observed. Their calculated speed in deep water is 78·75 s.m.p.h., and their wave-length 2,594 ft. Owing to the exceptional violence of the winds during this season the Meteorological Office collected all available data of weather in the North Atlantic, and published an atlas showing the size and position of the depressions and the direction and strength of the winds. It shows nothing on January 31st or February 1st to account for the swell observed at Branksome Chine on February 1st; but on January 30th there was a solitary deep depression with wind a little S. of W. of force 11–12—*i.e.*, velocity 64–77 s.m.p.h. From the actual situation of the depression this direction is true for the entrance to the English Channel. In order that the waves should reach Branksome Chine at the time of my observation they would have to advance at a speed of 40·8 s.m.p.h.

The waves which I observed travelling individually at 78·5 s.m.p.h. would advance *as a group* at half this speed, viz., 39·75 s.m.p.h. As no wind force 11–12 was recorded at sea on January 31st and February 1st, the height of the individual waves would not be maintained by the wind, and the front member of the group would continually be dying out, to be replaced by a new member in the rear; so that it is the group velocity, and not the individual velocity, which has to be calculated in tracking these waves to their source.

There is considerable probability, therefore, that the waves with an individual velocity of 78·5 s.m.p.h., which I observed at Branksome Chine, were produced by wind of velocity 64–77 s.m.p.h. at 2,000 miles; that is to say, 4,000 wave-lengths distance.

The question of the time during which these high velocities of wind were maintained must also be considered. During this stormy season an average velocity of 53 s.m.p.h. (Beaufort's 10) was maintained, as observed on land, for six hours on January 12th, 1899, and 70–76 s.m.p.h. for one hour.* During the same month a velocity of 80 to 90 s.m.p.h. was attained by gusts of wind.† The highest recorded velocity in any gust of wind of which I have knowledge is 103 s.m.p.h.

Thus the greatest velocity of waves calculated from the longest periods of breakers which I have observed is practically equal to the speed of the wind as indicated by the highest logged numbers at sea, and the highest average velocity of wind maintained for one hour on land during the same season. I should add that the group of twelve breakers of 22·5 seconds period were of not inconsiderable size, considering the somewhat sheltered situation in which they were observed, and the group of 19 seconds period (66·5 s.m.p.h.) were unusually large. Thus the observations indicate, first, that waves travelling as fast as the average velocity of the strongest winds form large breakers upon the shore; and, secondly, that, if there be swifter waves produced directly or indirectly by the action of wind upon the sea, they do not attain sufficient height to form noticeable breakers.

Combining the results of the observations at sea with those from the shore, I consider that I am now in a position to propose a settlement

* F. J. Brodie, *Quarterly Journal of the Royal Meteorological Society*, 1902.

† *Symond's Meteorological Magazine*, May, 1900.

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of the long-debated question of a formula which shall express the connection between the speed of the wind and the dimensions of the highest waves which it produces in deep sea far from land. As already stated, the records of average height in feet observed at sea are approximately equal to half the velocity of the wind in statute miles per hour. For those occasions on which the wind has had as full opportunity as it ever enjoys of doing its work, direct proportionality still holds good, but the constant is higher. I find that seven-tenths best satisfies the available observations between a strong breeze and a whole gale. The same simple proportion would not hold if we began with the heights corresponding to the gentlest breezes, which would probably rise in a steepening curve; but the only part of the line which is of nautical importance is that part which comprises waves of considerable size, and this part is a straight line.

My chief difficulty in obtaining a general formula has hitherto been the determination of the relation between wave-length and velocity of the wind. Having now, however, found that the highest waves finally formed are those travelling at a velocity which is equal, within the errors of observation, to that of the wind, their length can be directly calculated from the observed velocity of wind. I thus obtain the table given on page 1109, which shows the height and length, and, therefore, also the steepness, of the highest waves finally produced in deep sea far from sheltering land by winds of the different velocities corresponding to the numbers from six to twelve—strong breeze to hurricane—on Beaufort's table of wind force.

It will be noticed that, since I find the velocity of the waves to be equal to that of the wind, their length, according to the theory of waves, is proportional to the square of the velocity of the wind. Now I find the height to be proportional to the velocity of the wind. The height divided by the length—that is to say, the steepness—of the waves is, therefore, inversely proportional to the velocity of the wind. The table gives the steepness of the highest waves formed by wind of any velocity, but the waves are steeper before they acquire their final speed and greatest height.

In the table two constants depend upon observations, viz., the equality of velocity of wave and velocity of wind, and the factor 0·7 for converting velocity of wind in statute miles per hour to height of wave in feet. The other factors employed are given by the theory of trochoidal waves travelling in deep water.

General Formula for calculating the length and height of the waves finally produced in the open sea by the action of winds of any velocity from 25 to 77 statute miles per hour.

This formula is based upon—(1) The observation that in prolonged storms, or when the wind blows directly upon a swell of less than its own speed, the waves travel with the same speed as the wind, within the limits of the errors of observation. (2) The observation that the breakers of longest period have a calculated deep-water velocity equal to the maximum average velocity of wind recorded for the same spell of weather. (3) The observation of heights of fully-developed waves at sea. (4) The relation between speed, period, and length of waves given by the theory of trochoidal deep-water waves; employing the formula — speed of wave in feet per second $= 5\cdot123 \times$ period $= \sqrt{5\cdot123 \times \text{length}}$ (*vide* Chapter V. of Sir Wm. H. White's "Naval Architecture"), and converting from feet per second into statute miles per hour by use of the factor 0·6818.

Description of Wind.	Beaufort's number for wind-force.	Velocity of wind (V) in statute miles per hour = Velocity of wave.	Period in seconds = V ÷ 3·493.	Length in feet = V² ÷ 2·382.	Height in feet = V × 0·7.	Length ÷ Height = V × 0·600.
Strong breeze .	6	25	7·2	262	17·5	15·0
Moderate gale.	7	31	8·9	404	21·7	18·6
Fresh gale. .	8	37	10·6	575	25·9	22·2
Strong gale .	9	44	12·6	813	30·8	26·4
Whole gale .	10	53	15·2	1180	37·1	31·8
Storm . . .	11	64	18·3	1720	44·8	38·4
Hurricane .	12	77	22·0	2489	—	—

Note on the Height of Waves.—The figures are for the average waves. When their speed is equal to that of the wind, there is not the great variation in height which occurs when the wind has a velocity less than that of the swell left by a preceding storm and occasional high waves are formed by superposition.

Note on the Length of Waves.—When the length is judged by the apparent distance which separates two wave-crests viewed simultaneously, the result is generally much less than the true length. Unless special precautions are taken, the eye is completely deceived. Reliable

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Comparison of Observed Dimensions of Waves with those Calculated by the General Formula (the dimensions are given in feet).

Observer.	Description of wind.	Beaufort number (1–12).	Corresponding velocity of wind in s.m.p.h.	Observed velocity of wave in s.m.p.h.	Observed period of waves.	Period by the formula.	Observed height of prevalent waves.	Highest waves observed.	Height of the final waves by the formula.	Observed length of waves.	Length by the formula.	Observed ratio, length divided by height of the prevalent waves.	Ratio, length divided by height of final waves by the formula.	Locality.	Date of observation.	Remarks.
Cornish	..	..	21	..	6·8	6·0	..	..	..	..	..	..	..	Caribbean	Apr. 12, 1912	Wind dead aft; velocity of wind from smoke of funnel; steady wind; no swell.
Cornish	Strong breeze	6	25	..	..	..	15	Greater than 20	17·5	200	262	13·3	15·0	Caribbean	Jan., 1907	Between Colon and Jamaica. Trade wind exactly ahead.
Abercromby	Moderate gale	7 with 8 in squalls	32	33·75	..	..	21 to 26 average 24	26	22·4	445	430	18·5	19·2	S. Pacific	June 10, 1885	Aneroid showed total rise and fall, 35 feet.
Scoresby	Fresh gale	8	37	..	..	..	26	..	25·9	560	575	21·5	22·2	N. Atlantic	Mar. 6, 1848	800 geographical miles from windward shore.
Cornish	Strong gale	9	44	..	..	..	29	43 in peaks	30·8	..	..	..	..	Do.	Dec. 7, 1900	1,000 geographical miles from windward shore.
Scoresby	Do.	9	44	..	..	..	30	40	30·8	..	..	..	..	Do.	Mar. 5, 1848	600 geographical miles from windward shore.
David	Do.	9	44	..	..	..	40 to 45	One of 50	30·8	675	813	15·9	26·4	S. Indian	Aug., 1907	
Paris	..	..	46	..	..	..	30 waves of 29·5 feet	6 waves of 37·7 feet, and some higher	32·2	771	889	26·1	27·6	Do.	Oct., 1867	
Cornish	..	..	46·5	..	13·5	13·3	Greater than 31	..	32·5	..	..	..	..	Bay of Biscay	Dec. 21, 1911	Ship hove to; observations unusually easy.
Cornish	Storm to hurricane recorded at sea	11 to 12	64 to 77	..	19 to 22·5 swell observed on shore	18·3 to 22	..	45 to 52 reported at sea	44·8 to 53·9	..	..	..	..	Dorset Coast	Dec., 1898 and Feb., 1899	Data for weather and waves in the Atlantic from a report of Meteorological Council; observations on shore by Cornish.

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results are obtained by determining the time occupied by the waves in running the length of the ship combined with the interval of time between the arrival of the waves. This mode of measurement is, of course, independent of the theory of the relation between period and length.

Note on "*Force* 12."—A short group of breakers of the corresponding period have been observed by the author; but there is no reliable record of a sea in which the height of the waves averaged 53·9 feet, presumably on account of the extreme force of wind not being long maintained. Breakers corresponding in period to force 11 have been recorded in a long series.

I anticipate that seamen will object that the wave-lengths given in the table exceed their experience of the apparent length of waves. I have pointed out elsewhere* that although there is agreement between the records of systematic observation of heights of waves and the experience of navigating officers, there is a discrepancy in the matter of wave-lengths. Wave-length in the case of systematic observations has generally been determined indirectly by noting the time occupied by a wave-crest in running the length of the ship and the interval of time between the arrival of successive waves. The result is to give wave-lengths much greater than those generally assigned by officers on the bridge who notice the apparent distance between contiguous wave-crests viewed simultaneously. Only in the case of very long and regular waves, such as those seen in westerly storms in the Southern Ocean, is there an approach to concordance. For ordinary rough weather in the North Atlantic the discrepancy is about 100 per cent., the general estimate of seamen being about one-half that obtained by systematic observation of succeeding waves. Observing from the promenade deck of passenger steamers, I found that my estimate of the apparent length of waves viewed simultaneously agreed, on the whole with that of the navigating officers, and was much less than that calculated by theory from my observation of the periods. It was only on my voyage in December, 1911 (Marseilles to Plymouth by P. & O. s.s. "Egypt"), that I was able to satisfy myself as to where the truth lay. On December 19th, off the coast of Portugal, there was a heavy swell occasionally rising to more than 20 ft., and with a period of about 11 seconds. I came to the conclusion that when judging the distance between crests of succeeding waves along the ship's side my eye had in the past been deceived owing to the steep slope at the shoulder and the almost flat top of the waves. I decided that I had taken points a little beyond the *shoulders* of the receding and advancing waves as their summits, and thus systematically underestimated the wave-length by a large amount. Two days afterwards I had an opportunity of testing the matter, and convinced myself that the appearance which had so long deceived me commonly deceives even the practised eye of the seaman. When on the passenger deck of the s.s. "Egypt" at 9 A.M. of December 21st, the day of the storm already referred to, I was unable to satisfy myself whether the waves were or were not as long as the ship—512 ft. I had not the opportunity of obtaining at the moment the opinion of a navigating officer, but one of the engineer officers was good enough to address himself to the subject. He judged the length of the waves to be about 200 ft. As we were hove-to head to wind, the conditions were favourable to observation. Going on to the navigating bridge, I had from this position of vantage no difficulty in deciding that the large and regular waves were longer than the ship, for the stern was on one crest when the next crest had not yet arrived at the dipping bow. I estimated the wave-length at 100 ft. longer than the ship, and this estimate was approximately confirmed by the indirect measurement of length, and both were in fair agreement with the length theoretically calculated from the period. A navigating officer who co-operated with me in observing the same waves as they took the ship within their length, estimated their length at 542 ft. as against my 612 ft.; but another navigating officer on the bridge, who had been noticing the sea but not joining me in my systematic observations, judged the length of the waves to be 180 ft. The observations given in the table prove beyond reasonable doubt that the waves were quite 600 ft. long. At the time when the engineer officer from the passenger's deck estimated the waves at 200 ft. the observation of period gives their theoretical length at 800 ft., and my observations on the bridge proved that the lengths calculated from period were the actual lengths.

I do not think, therefore, that there is any longer room for doubt that, unless special precautions be taken or the circumstances be specially advantageous, the eye is completely deceived in judging the length of waves from the apparent distance between contiguous crests viewed from on board ship. Error is least when the eye is high above the waves.

* "Waves of the Sea and other Water Waves,' 1911.

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AUSTRALIAN MANUFACTURES.

The present rush of emigrants to Australia calls attention to the remarkable development of the Commonwealth during the last fifty years, and especially to the expansion of home manufactures. The days when the wealth of Australia was represented only by mines and sheepruns are long past, and the quantity and variety of goods exported give proof of the expansion of the resources of the country. A limited number of statistics respecting these industries are to hand, and from these we propose to quote in this short article.

The term "factory" is used throughout the Commonwealth to indicate any workshop, mill, or factory where more than four persons are employed. Annual conferences of statisticians have supplied valuable data, but the results are not totally satisfactory, as some States do not collect statistics with as much method as others.

The following table gives the latest annual report of the total value of the output of factories in the Commonwealth. It is taken from the last edition of the official Year Book of the Commonwealth of Australia:—

In this table the articles have been arranged according to their individual monetary value for the convenience of the reader, rather than under class headings. Under "Food and Drink" twenty-one different kinds of manufacture are reported. These include bacon-curing and the preparation of other dairy produce, confectionery, canning and preserving, ice and refrigerating, sugar mills and refineries, breweries and aerated waters. Over two and a half million sheep are treated every year, besides vast quantities of hares, rabbits, and poultry.

Jam-making and fruit preserving have largely increased with the development of orchards and fruit-growing. The industry is young as yet, but is capable of considerable expansion. During the last ten years confectionery and biscuit-making have also greatly expanded.

Large refrigerating works have been installed in various parts of Australia. The export of mutton and lamb preserved by the cold process now amounts to £1,200,000 a year. Much attention is paid to breeding in all the States.

Sugar-milling began in Australia long before sugar-refining. The raw material used was brought from Mauritius and the East. Several

Total Value of Output of Factories in Commonwealth, 1909.

1	Food and drink	£38,337,097
2	Metal works and machinery	19,692,545
3	Clothing and textile fabrics	12,572,309
4	Treating raw material product of agricultural and pastoral pursuits	9,258,911
5	Working in wood	6,344,019
6	Books, paper, printing, and engraving	5,299,607
7	Heat, light, and power	3,362,428
8	Vehicles and fittings; saddlery and harness	2,375,974
9	Processes in stone, clay, and glass	2,118,605
10	Drugs, chemicals, and by-products	2,089,747
11	Furniture, bedding, and upholstery	1,836,311
12	Treating oils and fats (animal and vegetable)	1,635,063
13	Minor wares	814,147
14	Jewellery, timepieces, and plated ware	534,804
15	Ship and boat building and repairing	479,646
16	Leatherware	352,890
17	Musical instruments, etc.	141,304
18	Arms and explosives	122,361
19	Surgical and other scientific instruments	41,965
		£107,409,733

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small home mills have been closed owing to the preference for cane-crushing in mills with modern machinery. On the north coast of New South Wales certain land formerly devoted to sugar growing has been turned into pastures and used for dairy purposes.

The trade in Australian wines is growing steadily as the excellent qualities of the vintage become known in other countries. In addition to grapes for wine-making, large quantities are grown for table use and for drying. A considerable amount of fresh fruit is exported.

The metal works include agricultural implements, cutlery, engineering, ironworks and foundries, railway carriages, lead mills, railway and tramway workshops, wire-working and other metal works. Many of the tramways are owned by private companies; the electric tramways of Brisbane, for instance, have an office in London. Hundreds of miles of tramways are used for special purposes, such as those employed in the sugar-milling industry for hauling cane to the mills. In each State railways are under the control of the Government, except in cases presenting unusual circumstances.

There are now a considerable number of large and important engineering works which engage in the manufacture of special classes of machinery and implements, besides those which provide for local domestic requirements. The manufacture of agricultural implements is very important, and is of special interest, as it is one of the first industries to which an attempt was made to apply the "New Protection" system, as it is called. Amongst machines made the "stripper-harvester," which combines the stripper with a mechanism for winnowing and bagging grain, is an Australian invention, and is exported to many countries.

The clothing made in the Commonwealth includes excellent home-made tweeds, flannels and blankets, of which the hard-wearing qualities are valued. There is no cotton-spinning or weaving or linen-weaving carried on in Australia. There has been cotton-ginning from time to time, and a mill was lately reopened at Ipswich in Queensland. Hat and cap-making, and the manufacture of boots and shoes, are also flourishing industries.

Details with regard to vessels built in the Commonwealth are somewhat meagre. Twenty-nine steam vessels and twenty-three sailing vessels were built and registered in 1909.

The trade in hides forms a considerable export. Between the years 1905–9 no less a sum than £9,071,345, or an average of £1,814,269 per annum, was represented. The largest item included arises from the sheepskins with wool, which are shipped chiefly to France and the United Kingdom. The quantity of wool alone sent from the Commonwealth between 1905–9 amounted to £119,757,161 in value. The value of Australian wool imported into the United Kingdom in one year is £13,668,466.

There are between three and four hundred factories engaged in furniture and cabinet-making and billiard-table making in Australia. The total value of the annual output when the last statistics were collected was £1,193,308.

It has not been possible to obtain satisfactory information concerning wages in all parts of Australia. The rates in many industries vary considerably in different parts of the country. Then again, the necessary particulars are not collected by the several States on a uniform basis; while for some States the information given is meagre and unsatisfactory. The highest amount paid in salaries is in metal works and machinery—£5,194,376. The clothing and textile fabrics industry comes next with a wage list of £3,599,178. The minimum amount is in the surgical and scientific instrument trade. The State in which the largest amount of salaries is paid is New South Wales, which totals £7,665,125, or nearly ten times as much as is paid in Tasmania.

The average amount of wages paid per employee in 1909 was £87·27 in New South Wales, £73·57 in Victoria, £82·09 in Queensland, £83·08 in South Australia, £122·21 in Western Australia, £87·78 in Tasmania, £83·01 in the Commonwealth.

Women are employed in increasing numbers in Australian factories. The number of women to 100 men is about 35·76, as against 32·78 eight years ago. The increasing percentage is due to the activity of the trades in which women are usually engaged rather than to the substitution of female for male labour. Large numbers are occupied in tailoring and dressmaking, in wholesale manufactures, in tobacco factories and preserving works.

The employment of children is mainly confined to a limited number of industries, the most important being paper-making, dressmaking and millinery, and clothing. In New South Wales no child may be apprenticed under the age of fourteen years; in Victoria and Queensland, twelve years. There is no limitation in the case of other States, nor any regulating Acts, except as applying to charity apprentices.

URANIUM: ITS DISCOVERY, CHEMICAL COMPOSITION AND USES.

The metal uranium is somewhat sparingly distributed over the surface of the earth, principally in the mineral pitchblende, which consists almost entirely of oxygen and uranium (other rare metals in a more or less degree are associated with pitchblende).

Pitchblende, a dark mineral named from its characteristic fracture very similar in shape and colour to that of hard pitch, is interesting as being the mineral in which uranium was first discovered, and which contains, so far as at present known, the greatest amount of radium of all the minerals; whilst the species called chalcolite, uranite, and

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the various other compounds are recognisable by their brilliant colours of green and yellow crystals.

Uranium was discovered in 1789 by the German chemist Klaproth, and the metal was first isolated by Peligot, the substance originally supposed to be the metal having been proved by him to be the protoxide.

The metal is obtained by several processes, the most simple being by heating the protochloride with potassium. The metal uranium thus obtained is of a white colour, and to a certain extent malleable; if heated in the air it burns brilliantly, like magnesium.

The protoxide is made by heating the oxalate of uranium in a current of hydrogen in closed vessels. It is a black powder which takes fire spontaneously on exposure to the air. It was formerly supposed to be the metal. In its anhydrous state it is insoluble in acids, but as a hydrate precipitated from its salts by ammonia it is readily soluble, forming numerous salts of an interesting character.

The nitrate is the source from which most of the compounds of uranium are procured. It is prepared from pitchblende by solution in nitric acid, the lead, arsenic, iron, and other metals and impurities, being extracted by well-known means. It forms fine yellow crystals with a peculiar green bloom running through them.

The nitrate has been used as a photographic material. The oxide has been employed in giving glass a peculiar greenish yellow fluorescent appearance of great beauty.

In the manufacture of the more expensive "Bohemian glass," uranium has played an important part. At the dinner-tables of many old families in England there are used wine-glasses and ornaments in the manufacture of which, through the use of uranium, radium to a certain extent entered. Always a rather costly kind of ware, it will now be more prized than ever. There are other salts of uranium than those already described which are very interesting to the chemist, from their anomalous composition and behaviour with re-agents, but it is not our province to describe them here. Uranium and its compounds emit peculiar rays—"uranium rays" —which can penetrate thin metallic screens and coins; these rays undergo reflection, refraction, and polarisation, and discharge electrified bodies.

Professor Henri Becquerel, in experimenting with uranium, concluded that it had the power of absorbing the sun's rays, which after exposure to the sun would cause an action on a photographic plate. It occurred to him that possibly a similar result might be obtained with pitchblende, and he discovered that this substance gave off rays of emanation which produced photographic images in the dark. It was this discovery of what is known as the "Becquerel uranium rays" in emitting radiation, which not only acted upon photographic plates, but had the power to penetrate solid substances exactly after the fashion of Röntgen rays, that led the Curies to follow out this discovery made by Becquerel respecting the rays of uranium; and when Madame Curie found that pitchblende was more than four times more radio-active than the separated uranium salts, it occurred to her to test the radio-activity of the residue after removing the salts from the pitchblende. Following out her investigations, she discovered that the radio-activity of the residue from the separated uranium was far greater than that of the pitchblende. Her husband now joined her in further investigations, in which they obtained a substance so powerfully radio-active that they proceeded to isolate the element, and they produced the chloride and bromide of radium in a state of purity sufficient to determine its essential properties.

Previous to this discovery by the Curies, the use of uranium was practically confined to use in porcelain painting, in the manufacture of glass, and in photography.

Although from the time of its discovery by Klaproth uranium has always commanded a high price, yet, owing to the comparatively small field in which it could be employed, the output of uranium ores was necessarily limited in order to maintain the market. The sources also of its supply have not been plentiful; but now search is being made in different parts of the world, particularly in Cornwall, for pitchblende, which, in order to procure radium, must be had at whatever cost.

The manufacture of radium from pitchblende does not interfere with the simultaneous production of uranium oxide, and, having regard to the large quantity of pitchblende necessary to produce a very small quantity of radium, it should follow that the supply of uranium will be greatly increased. This increase in the supply will tend to reduce the market price, and by so doing would encourage a demand for its practical employment.

As an illustration, it may be stated that uranium is one of the best-known conductors of electricity extant, and a reduction in price would inevitably increase its use in electrical construction.

Uranium mixed with steel is said to form an alloy of high quality, so that when its supply can be maintained in regular quantities, it would obviously be utilised in the manufacture of ordnance, for fine sword steel, and for other purposes of a similar character.

Bohemia can boast of the oldest uranium mine in the world, viz., Isachmisthal, which is situated on the Bohemian side of the Erzgebirge, in a very striking pass in the ore mountains. This mine has been very rich in silver; it is said to be one of the oldest in Europe, and the first for which mining laws were framed. It was from this mine that Klaproth is said to have procured the ores of pitchblende from which he discovered uranium.

It is near this mine on the southern slope of the mountains that uranium has played such an important part in the manufacture of the most

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expensive Bohemian glass. Other uranium mines of note are in the German Empire, in Saxony and Cornwall. Some fine specimens of the calco-uranite have also been obtained from St. Symphorni and a few other places, including the Black Hills of South Dakota.

The ores of uranium have long been known to exist in Cornwall, but previous to the discovery of a true fissure vein of uranium in South Terras Mine, near Grampound Road, had only occasionally been met with in pockets mixed with other minerals. In Huel Providence and Trenwith, St. Ives, it was mingled with the copper ore in places in quantity sufficient to diminish its value.

At Wheal Edward in St. Just rich pockets of pitchblende were met with, and the ore collected was sold at about £200 per ton. At East Pool, between Camborne and Redruth, have been found occasionally rich pockets of pitchblende. Specimens of all the varieties of uranium have been procured at Carharrack, Huel Garland, Tolcarn, Huel Unity, and Ting Tang in Gwennap, also from the following mining districts: Gwinear, St. Agnes, St. Austell, St. Stephens, near Grampound Road, and Calstock.

Although, as previously stated, "pockets" containing the ores of uranium were met with occasionally in several places in Cornwall, it was not until 1878 that it could be said that uranium mining in that county was of any industrial value. Up to that period small quantities had from time to time been selected and sold; since then, through the discovery of a true fissure vein of uranium in the South Terras Mine by the writer of this article, large consignments of the ores have been made.

This mine, including Blencowe to the west, which receives the uranium lode in depth, is very interesting, not only on account of its valuable products, but also in respect of the enclosing rocks in which this vein is embedded. The most extensive deposits of magnetite or magnetic iron ore in Cornwall are found, enclosed within a mass of trappean rock, in places predominated by beautiful dark green and black flaky crystals of hornblende, garnet-rock, extensive beds of steatite, etc. Most of the meteoric metals are found here. Near the base of these eruptive rocks and crossing them in a northerly direction, with an inclination westward, is the uranium lode or vein.

J. H. Harris-James.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Artificial Waste Silk.—The objective of manufacturers of chemical silk has been hitherto the production of continuous filaments, such as are reeled in long lengths from the cocoon. The direction is an eminently natural one to take, as they thereby imitate silk in its dearest form by the means which must probably be always the cheapest method to adopt. The filaments made by solidifying streams of jelly squirted through the orifices of a rose, have to support their own weight and some strain in combining them together to form a merchantable yarn. Thus a limit is set to their tenuity, and in the present state of advance the individual constituents of an artificial silk yarn are coarser, and hence fewer, than in a real silk of the same diameter. In view of certain purposes, this constitutes a severe disadvantage. It may be hazarded that one reason why artificial silk spreads, or covers, less well than natural silk in weaving is that there are fewer fibres within it. Patently, when woven with an erect pile of cut loops it is impossible that a yarn composed of few and coarse filaments should create so rich an effect as one with many more fine points. Partly for this reason, the artificial silks generally known do not lend themselves satisfactorily to making velvet. There thus emerges a practical question of how the fineness of the ultimate constituents may be reduced. The inventors of what is called "new schappe" yarn have proceeded by abolishing the continuity of length. Instead of making indefinitely long fibre, they produce short fibres of a definite length, corresponding to those recovered from waste silk by the silk dresser, and by him made upon spinning machinery into spun yarn. These "drafts"—to give them the name applied to natural silk—are some six times finer than the fibres that can conveniently be employed in making chemical silk by the older methods. For the first time we are faced with commercial proposals to manufacture artificial waste silk, and a varied collection of samples of mixed and pure "new schappe" goods is on private exhibition in Paris. According to the statements of interested parties, the drafts could be produced at 7½*d.* per lb., on the scale of one ton per day, or at fractionally over 1*s.* 2*d.* on a smaller scale. As either of these prices is less than the net labour cost of converting silk waste into drafts, the competition might seem serious. Commercially, much depends on the subsequent cost of turning the drafts into yarn, and the price that yarn commands. There has at least been a technical advance sufficient to attract the serious attention of one of the largest Lancashire firms. The new material is said to take dye perfectly, and to be capable of modification under finishing treatments.

Textile Combines.—The closing years of the last century were the halcyon days of company promotion in the British textile industry, and nearly all the combines belong to that date. The successful floating of the J. & P. Coats combination in 1896 led easily to the English Sewing Cotton Company of 1897, the Fine Cotton Spinners' and Bradford Dyers' Association of 1898, and the Calico Printers' and Yorkshire Woolcombers' Associations of 1899. These were succeeded in 1900 by a fleet of seven new combinations, with the Bleachers' Association as chief. Schemes for other and larger undertakings were in the air, but in 1901 public confidence in the magic of combination met

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a violent death. The enthusiasm of the old century has never been recaptured, and with painful clearness it is seen that different combinations meet with very unequal fates. Vendors, in larger numbers than one might expect, have had time to rue the sale of their family businesses, managers have had cause to repent of numbers of their purchases, and investors' heads have been thoroughly cooled. It is not on English but Belgian and French initiative that new combines are being formed out of Lancashire spinning and weaving mills. According to inspired rumour, properties capitalised at £3½ millions are to be floated before Christmas. If low first costs are wanted, this is not a signally opportune time to buy, as current financial results are good enough to cause owners to hold tight to their mills. Neither is this an advantageous time to build if looms and materials have to be contracted for at current prices. The cotton-weaving trade is in one of its periodical bursts of expansion, with 5,000 new looms under installation in Blackburn, 3,500 in Burnley, and 1,000 in Nelson. For the most part these represent purchases made some while ago, and they do not constitute the whole extension during this year. As last year saw over 17,000 new cotton looms added in Lancashire, the leeway between spindles and looms is being caught up at a good rate. Machines cry for work in dull times as well as in good, and competition is intensified by their number. The usual hints as to economies are thrown out in connection with the new combines, but the possible savings on normal practice are remarkably restricted in the cotton trade. It is a commonplace to say that no well-established concern in the spinning or weaving industries has not realised the extreme advantage of carrying a light load of capital obligations. The success of cotton mills can almost be measured by the extent to which the capital values have been written off in the books, and their fortune alternates between short periods of excellently profitable times and long periods of dull trade.

War Influences.—A European war made the fortunes of the West Riding forty years ago, and "Franco-Prussian profits" might fitly be carved in the stonework of scores of warehouses and mansions surviving to-day. Manufacturers not accustomed to make thousands a year made thousands a month for a short while without overtaxing their ability. To be able to manufacture and deliver woollens or worsteds at all was enough to secure high prices during the disablement of Continental competition. Civil war in America closed half the mills in Lancashire, brought one quarter of the operatives to beggary, and cost Lancashire trade some £70 millions. More recently, a war in which Britain was not engaged, induced a feverish demand for woollen khaki and army blankets for Japan. The South African War had its industrial compensations, but none is imminent from the Balkan fighting. Yorkshire supplied Turkey with great quantities of khaki and grey overcoating two or three years ago, but since then the Turkish Government and private mills have entered the woollen army cloth business. Turkish summer uniforms are largely made of light, cheap Italian cotton-drill. Bulgaria and Servia both have mills to make army woollens, although there is no more certainty that these will be able to work than that supplies could be paid for or carried from this country. The Ottoman Empire, comprising Asiatic as well as European Turkey, is the third in importance of the markets for British cotton goods, and for the time being the business is thoroughly dislocated. The same is the case with the less important trade in heavy woollens done with Turkey. The regular supplies to the countries of the Allies are of less direct importance, as their business falls largely to manufacturers in their own and the neighbouring countries. Indirectly, the British textile industry is in a position to feel every shock. If those who supply the Near East consume less yarn our spinners feel it. If credit contracts so that Continental manufacturers are not disposed to buy raw materials as heavily, or at as high prices as hitherto, the effects exert their influence here in a fall of price. Uncertainty has many doors by which to enter from such a situation as prevails in the Levant, and the restraint on free dealing is a great deal more evident than any encouragement that can conceivably be lent to textile business.

Cotton-baling.—When an American judge stigmatised the American cotton bale as "a dirty, damaged, disreputable, water-soaked, wasteful, slovenly, clumsy, highly-inflammable, turtle-backed package," it was generally felt that language could go no further and that measures of reform would have to ensue. Six years of hearty accordance with this anathematisation leave the bale unaffected. The reasons for its lamentable condition are rather better understood, and tentative recommendations for its improvement have recently been made by a Washington official. The raw cotton is sent from the farm to the ginnery to be stripped from the seed and be packed in ginners' bales of a superfluously heavy and wretchedly inferior canvas. The bale weighs roughly 500 lbs., and conveys 19 to 24 lbs. of bagging and hoops. Gin presses in America are inefficient, and before export the bale has to be reduced in size to economise freight. For this purpose it is sent to a compress, owned, like the bagging factories, by a trust. Export cotton is sold on a contract known as the "c.i.f. and six," descending from the days of lighter cotton bales, and sanctioning a tare of 6 per cent. (30 lbs.). The ginnery tare of an average 22 lbs. is excessively heavy to begin with, but in order that the shipper shall not lose any weight, the weight of packing is bloated to the full 30 lbs. or beyond at the compress to the shipper's orders. The rules do not admit of the adding of more than a specified number of hoops, or the difference might be made up in steel.

Accordingly there are sewn to the bale a number of patches of second-hand bagging proportionate to the circumstances, and cotton shippers take frankly into calculation their profit on patching. The Egyptian bale, weighing 720 lbs. net, arrives in immeasurably better condition than the American, with a 3 per cent. tare, and the Indian bale is efficiently protected by a 2 per cent. tare. Under the joint influence of superannuated contract rules, the poverty of planters and ginners, the interests of middlemen and trusts, and the force of old custom, this inefficiency survives. Sea freight at some fifteenpence per 100 lbs. is paid on thousands of tons of ragged jute, whose only service is a pernicious one. Bales are needlessly damaged by water or destroyed by fire because the packing is inefficient. The cotton is soiled, and carelessness in its handling is stimulated by the force of bad example. No similarly valuable produce is so scandalously mishandled, yet nothing more tangible than a suggestion to change the export contract is forthcoming officially from America. The proposal is that a conference should be called representing the whole cotton-using world to determine on some such measure as the curtailment of the 6 per cent. tare to five per cent. There are potentialities of good in this mild palliative measure, but where so much is wrong consumers may excusably feel that their assent should be conditional upon some promise of spontaneous improvement in baling conditions.

CORRESPONDENCE.

COLONIAL REPRESENTATIVE GOVERNMENT.

I have read Mr. Latham's contribution with great interest. No doubt Virginia took advantage of her opportunities earlier than Barbados, but there was a proviso in the grant to Lord Carlisle which enabled him to play the role of autocrat for a considerable period. It must be remembered that his Charter gave him control of the whole of the Caribbee Islands, twenty-three of which are enumerated, and these include the present Windward and Leeward Islands, as well as Martinique, "Guardaloup," "Marygalanta," etc., and it is no wonder that the following was added to the grant: "And because in the government of so great a Province, oftentimes sudden occasions do fall out, to which it shall be needful to apply a remedy, before the free inhabitants of the said Province can be called; and for that it shall not always be needful in such cases that all the people be called together, therefore for the better government of the said Province We Will and Ordain, and by these presents for Us our Heirs and Successors, have granted to the said James Earl of Carlisle and his heirs by himself or his Magistrates and Officers in that behalf lawfully preferred, may make decrees and Ordinances both fit and profitable from time to time..."

So far as I have been able to discover, the first assembly was called after the arrival of Francis Lord Willoughby in May, 1650, and met on November 4th, 1651. The Governor appears to have been busy for some months resisting the fleet sent by Cromwell to reduce the islanders to submission, but they remained loyal to the King, and the meeting was convened to agree upon and sign a declaration, setting forth their "loyalty and firm intentions to defend His Majesty's just interests and lawful power, with the person of the Lord Willoughby." Cromwell, however, found the Barbadians too much for him, and he was obliged to make an arrangement very favourable to the islanders, embodied in an agreement dated January 17th, 1652, between certain Commissioners, appointed on behalf of the Commonwealth by Sir George Ayscue, the Admiral in command of the Fleet, and on behalf of the Colony, by Lord Willoughby. Under this agreement, "the Island of Barbados, with all the forts, sconces, and fortifications thereof, and all the artillery, public arms, and ammunition," were to be delivered up into the hands of Sir George Ayscue for "the use of the States of England" by a specified time. No punishment was prescribed to the rebels, and Lord Willoughby was granted liberty "to go to England, and there to stay or depart at his pleasure, without having any oath or engagement put upon him, he acting or attempting nothing prejudicial to the State or Commonwealth of England." It was also provided that an "Act of indemnity be, with all convenient speed, passed in the Parliament of England to save, keep harmless and unquestionable all and every the inhabitants of this Island that are comprised in these Articles for or concerning any act or thing whatsoever done by them, or any of them at any time or place," and, moreover, ordered "that an Act made the 3rd day of October, whereby the inhabitants have been declared traitors, may upon this accord be taken off the file from the records."

This agreement was signed on January 17th, 1752, and the Government of the Colony passed into the hands of Sir George Ayscue, representing the Commonwealth. Notwithstanding the terms of the agreement, on March 4th of the same year a new Legislature which had been summoned, passed an Act by which Lord Willoughby was ordered to embark in a ship for England under penalty of being considered an enemy to the peace, nor was he to return unless permitted by Parliament. On the same day another Act was passed, banishing Colonel Humphrey Walrond, Mr. Edward Walrond, Colonel Shelley, Major Byam, Lieutenant-Colonel Guy, Colonel Ellis, Captain Jarmin, Captain Bowcher and Captain Usher.

Sir George Ayscue left Barbados on March 29th, 1652, having previously signed an Act of the Legislature authorising Colonel Daniel Searle (one of the Commissioners under the agreement) to assume the government without dissolving the Assembly, and another providing that all Acts

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passed under Lord Willoughby for the defence of the island were to be "repealed, expunged and blotted out of the books of records to the intent that they may be no more seen and perused, but buried in oblivion."

Lord Willoughby returned to Barbados as Governor in August, 1663, after the Restoration, but was lost in a hurricane off the island of Guadeloupe, on or about August 4th, 1666, and was succeeded by his brother, William, Lord Willoughby, who arrived in the island in June, 1667.

G. T. CARTER,
Late Governor, Barbados.

OBITUARY.

SIR (JOHN) IRVING COURTENAY. — The death occurred on October 22nd, at his residence in St. James's Court, of Sir (John) Irving Courtenay. Born in 1837, Sir Irving was educated at Cheltenham and Trinity College, Oxford, and subsequently, in 1861, called to the Bar by Lincoln's Inn. He was a pioneer of the electrical industry in this country, and was interested in a number of undertakings, at home and abroad. He was also a keen politician, being the first chairman of the City of London United Liberal Association. He received the honour of knighthood in 1907. He joined the Royal Society of Arts in 1892, and in addition to this was a member of the Institute of Electrical Engineers and a Fellow of the Royal Geographical Society.

HYLTON WILLIAM DALE.—Mr. Hylton W. Dale died on October 26th at the age of fifty-six. He was educated at University College School, and in 1872 entered his father's business, Messrs. Charrington, Sells, Dale & Co., of which firm he became a partner in 1881. For forty years he was well known on the London Coal Exchange, where he was recognised as an authority on the coal industry. He served for some years on the committee of the Coal Merchants' Society, and was one of the original committee of the Coal Trade Benevolent Association. He became a member of the Royal Society of Arts in 1905.

GENERAL NOTES.

MEMORIAL TABLETS.—A bronze tablet has been affixed by the London County Council to No. 36, Onslow Square, South Kensington, the residence of William Makepeace Thackeray from 1854 to 1861. It was here that he wrote the "Lectures on the Four Georges," the end of "The Newcomes," and "The Virginians," part of "Philip," and many of the "Roundabout Papers." This is the fourth of Thackeray's homes to be commemorated—the others being No. 28, Clerkenwell Road, where he boarded during part of his school time at Charterhouse; No. 16, Young Street, Kensington; and No. 2, Kensington Palace Green, where he died. The tablet on the last-mentioned house was erected by the Royal Society of Arts before this work had been handed over to the London County Council. A tablet has also been placed on No. 9, Arlington Street, which was the residence of Charles James Fox during the parliamentary sessions of the years 1804–1806.

COTTON WORM AND BOLL WORM COMMISSION, EGYPT.—In view of the serious losses which cultivators in Egypt have experienced during recent years through the ravages of the Egyptian cotton worm (*Prodenia litura*) and the boll worm (*Earias insulana*), His Highness the Khedive has approved the formation of a special commission, under the presidency of His Highness Prince Hussein Pasha Kamil, to investigate the means of preventing the recurrence of these pests, or of destroying them when they appear, thereby assuring that the cotton crop shall not remain liable to such disastrous consequences as hitherto. In order that the investigation should be as complete as possible, the Commission, at the first meeting, appointed a sub-committee, including two reporters, selected from among the technical and scientific members of the Commission itself, whose duties, in addition to that of carrying out original experimental work, consist of the examination of all schemes and suggestions presented to the Commission. The Commission invites the co-operation of agriculturists and men of science throughout the world, and has directed the sub-committee to prepare, publish, and circulate accounts of the exact nature of the two pests mentioned above, in such a manner that they may be clearly understood by all. It is contemplated that, with the information thus supplied, a sufficient indication of the local conditions may be conveyed to enable suggestions to be sent in for consideration, which have been prepared by persons not necessarily personally acquainted with Egyptian agriculture. The sub-committee will undertake experiments with any process suggested, which indicates a reasonable probability of success, but cannot employ any chemical mixture the component parts of which have not been made known. No attention can be given to methods involving secret processes or remedies. All communications upon the subject of remedies or with regard to further information upon any point should be addressed to the sub-committee, "Commission du Ver du Coton et du Ver de la Capsule," Department of Agriculture, Egypt.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 4...Farmers' Club, Whitehall Rooms, Whitehall-place, S.W., 4 p.m. Mr. Hart-Synnot, "The Development Fund and its Distribution."

Engineers, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7.30 p.m. Mr. W. P. Durtnall, "The Generation and Electrical Transmission of Power for Marine Transportation."

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Chemical Industry (London Section), Burlington House, W., 8 p.m. 1. Messrs. Clayton Beadle and H. P. Stevens, "The Nitrogenous Constituent of Para Rubber and its Bearing on the Nature of Synthetic Rubber." 2. Mr. A. J. Hale, "The Corrosion of Metals and Alloys in various Solvents." 3. Messrs. A. E. Dunstan and J. F. Strevens, "The Viscosity of Lubricating Oils."

Geographical, Burlington-gardens, W., 8.30 p.m. Miss Ellen Churchill Semple, "The Geography of Japan and its Economic Development."

British Architects, 9, Conduit-street, W., 8 p.m. President's Opening Address.

TUESDAY, NOVEMBER 5...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Alpine Club, 23, Savile-row, W., 8.30 p.m. Mr. E. Teichelmann, "Some New Ascents from the West Coast in the New Zealand Mountains."

Civil Engineers, in the Rooms of the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Inaugural Address by the President, Mr. R. Elliott-Cooper.

WEDNESDAY, NOVEMBER 6...Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 8 p.m. Mr. W. Marriott, "Meteorology and Public Health."

Geological, Burlington House, W., 8 p.m. 1. Professor Albert Charles Seward, "A Contribution to our Knowledge of Wealden Floras, with special reference to a Collection of Plants from Sussex." 2. Mr. Ernest Proctor, "Notes on the Discovery of Fossiliferous Old Red Sandstone Rocks in a Boring at Southall, near Ealing." With an Appendix on the Upper Devonian Fish-Remains, by Dr. A. Smith Woodward.

Public Analysts, at the Chemical Society's Rooms, Burlington House, W., 8 p.m. 1. Mr. Norman Evers, "The Detection and Estimation of Arachis Oil." 2. Mr. A. C. Chapman, "The Examination of Chinese and Japanese Wood Oil." 3. Mr. H. F. V. Little, "The Estimation of Maganese by the Bismuthate Method." 4. The President will exhibit an apparatus for testing the purity of water by measurement of its electrical conductivity.

United Service Institution, Whitehall, S.W., 3 p.m. Major-General L. B. Friend, "Some Problems of British Coast Defence."

Royal Society of Literature, 20, Hanover-square, W., 5.15 p.m. Professor Henry Newbolt, "Poetry."

Royal Archæological, at the Society of Antiquaries, Burlington House, W., 4.30 p.m.

British Academy, in the Theatre, Burlington-gardens, W., 5 p.m. (Schweich Lectures.) Rev. C. H. W. Johns, "The Laws of Israel and Babylon." (Lecture I.)

THURSDAY, NOVEMBER 7...Cyclists' Touring Club (Metropolitan District Association), at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Rev. M. Le Marinel, "With Cycle and Camera through Five Countries."

Linnean, Burlington House, W., 8 p.m.

Chemical, Burlington House, W., 8.30 p.m. 1. Messrs. W. G. Glendinning and A. W. Stewart, "Some Time-reactions suitable for Lecture Experiments." 2. Mr. J. Kendall, "The Problem of Strong Electrolytes." (Preliminary note.) 3. Messrs. I. M. Heilbron and J. A. R. Henderson, "Action of Semicarbazide Hydrochloride upon the P-quinones." (Preliminary note.) 4. Messrs. A. G. Green and S. Wolff, "Aniline Black and Allied Compounds." (Part III.) 5. Messrs. A. G. Green and F. M. Rowe, (*a*) "Nitro Hydrazo Compounds. Part III.—Influence of Ortho Groups on their Formation and Condensation." (*b*) "The Existence of Quinonoid Salts of Orthonitro Amines and their Conversion into Furazane-oxides." 6. Mr. E. A. Werner, "The Interaction of Azoimide and Nitrous Acid." (Preliminary note.) 7. Messrs. P. C. Ray and R. L. Datta, "Methylbenzyl-, Ethylbenzyl- and Allylammonium Nitrites." 8. Mr. E. de B. Barnett, "Note on the Action of Ethylene Oxide on Hydrazine Hydrate." 9. Mr. J. C. Philip, "Note on the Hydrolysis of Acetic Anhydride." 10. Mr. T. V. Barker, "Studies in Chemical Crystallography. Part I.—Coordination, Isomorphism, and Valency." 11. Messrs. A. Hopwood and C. Weizmann, "Condensation of Bromo-acylhalides with Glucosamine." (Preliminary note.) 12. Messrs. W. H. Mills and W. H. Watson, "Note on the Formation of Tetrachlorophthalyl Chloride by Chlorination of Tetrachlorophthalide." 13. Messrs. J. Ferns and A. Lapworth, "Note on the Preparation and Properties of Sulphonic Esters." 14. Messrs. R. T. Hardman and A. Lapworth, "Electromotive Forces in Alcohol. Part III.—Further experiments with the Hydrogen Electrode in Dry and Moist Alcoholic Hydrogen Chloride." 15. Messrs. J. I. Crabtree and A. Lapworth, "The Properties of α-Bromonaphthalene." 16. Messrs. A. P. N. Franchimont and H. J. Backer, "Absorption Spectra of the Cobalto Derivatives of Primary Aliphatic Nitroamines." 17. Mr. F. H. Carr, "The Oxidation of Aconitine." 18. Messrs. F. Tutin and H. W. B. Clewer, "The Constituents of Cluytia Similis." 19. Messrs. A. E. Dixon and J. Taylor, "The Constitution and Reactions of Thiocarbamides." 20. Messrs. C. W. Bailey and H. McCombie, "The Effect of Heat on a Mixture of Benzaldehyde Cyanohydrin and Metachloroaniline and Metatoluidine." 21. Mr. F. L. Pyman, "Pilosine: A New Alkaloid from Pilocarpus Microphyllus." 22. Messrs. H. A. D. Jowett and F. L. Pyman, "Note on the Alkaloids of Pilocarpus Racemosus." 23. Messrs. H. F. Coward, C. Cooper, and C. H. Warburton, "The Ignition of Electrolytic Gas ($2H_2 + O_2$) by the Electric Discharge." 24. Messrs. A. E. Dunstan, T. P. Hilditch, and F. B. Thole, "The Viscosity of Compounds Containing Two Unsaturated Groups in Varying Positions in the Molecule. A Comparison of the Effects due to Spatially Proximate and to Chemically Adjacent Unsaturated Radicles." 25. Messrs. A. E. Dunstan and F. B. Thole, (*a*) "The Relation between Viscosity and Chemical Constitution. Part V.—The Viscosity of Homologous Series." (*b*) "The Relation between Viscosity and Chemical Constitution. Part VI.—An Additive Relationship Afforded by Viscosity." 26. Messrs. G. G. Henderson and M. M. J. Sutherland, "Contributions to the Chemistry of the Terpenes. Part XIV.—The Oxidation of Pinene with Hydrogen Peroxide."

Automobile Engineers, Institution of (Graduates' Section), 13, Queen Anne's-gate, S.W., 8 p.m. Mr. Percy Bishop, "Design."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Professor Flinders Petrie, "Egyptian Art."

FRIDAY, NOVEMBER 8...Malacological, Burlington House, W., 8 p.m. 1. Mr. A. J. Jukes-Browne, "*Tivela* and *Grateloupia*." 2. Mr. G. C. Robson, "On some Remarkable Shell Monstrosities." 3. Messrs. R. Arnold and H. Hannibal, "New Mollusca from the Marine Tertiary Deposits of the North Pacific Coast of America." 4. Mr. H. B. Preston, "Descriptions of new species of *Limicolaria* and *Krapfiella* from East Central Africa."

Astronomical, Burlington House, 5 p.m.

Physical, Imperial College of Science, South Kensington, S.W., 8 p.m.

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Journal of the Royal Society of Arts.

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FRIDAY, NOVEMBER 8, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Fifty-Ninth Session will be held on Wednesday evening, November 20th, when an address will be delivered by LORD SANDERSON, G.C.B., K.C.M.G., Vice-President and Chairman of the Council. The chair will be taken at Eight o'clock.

The following arrangements have been made for meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 27.—HAROLD COX, "The Interdependence of Morals and Economics." SIR GEORGE RANKEN ASKWITH, K.C.B., K.C., will preside.

DECEMBER 4.—A. ZIMMERMANN, "The Manufacture of Sugar from Wood, and its Economic Importance."

DECEMBER 11.—DR. F. MOLLWO PERKIN, "Synthetic Rubber."

DECEMBER 18.—JOSEPH PENNELL, "The Pictorial Possibilities of Work." (Illustrated by a collection of etchings, prints, drawings, and paintings from the time of Rembrandt to the present, including a series of lithographs made at the Panama Canal by the author.)

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

NOVEMBER 26.—W. H. WARREN, LL.D., M.Inst.C.E., M.Am.Soc.C.E., Dean of Faculty of Science and Challis Professor of Engineering, University of Sydney, "The Hardwood Timbers of New South Wales." The RIGHT HON. SIR GEORGE HOUSTOUN REID, G.C.M.G., D.C.L., K.C., High Commissioner for Australia, will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 12.—J. FORREST BRUNTON, "The City of Karachi."

Papers to be read after Christmas:—

LEON GASTER, "The Economic and Hygienic Value of Good Illumination."

F. G. OGILVIE, C.B., LLD., "The New Science Museum."

MRS. COOKSON, "The Imitative Jewellery of the 18th Century."

ERNEST E. JESSEL, "The Cambodian Sculptures of Ankhor-Thom."

ERNEST MARRIAGE, "The Adulteration of Jam."

C. L. MACCARTHY, "Steel Pipes versus Cast-Iron Pipes for the Conveyance of Gas, Water and Air."

WALTER C. HANCOCK, B.A., "The Physical Properties of Clay."

ANEURIN WILLIAMS, "Co-partnership."

JAMES BUCKLAND, "Ostrich Farming as a British Industry."

E. RUSSELL BURDON, M.A., "The Development of Research Work in Forest Products."

EDMUND STREET and LIONEL JACKSON, "Advertising."

G. F. KEATINGE, C.I.E., I.C.S., "Agricultural Progress in Western India."

SIR WILLIAM LEE-WARNER, G.C.S.I., M.A., LL.D., "Kathiawar."

SIR JOHN BENTON, K.C.I.E., "Irrigation in India."

C. E. W. BEAN, M.A., B.C.L., "The Colonial Wool Industry."

INDIAN SECTION.

Thursday afternoons, at 4.30 o'clock:—

January 16, February 13, March 6, April 17, May 29.

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COLONIAL SECTION.

Tuesday afternoons, at 4.30 o'clock:—

January 28, February 25, April 29.

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Methods of Economising Heat." Three Lectures.

December 2, 9, 16.

PROFESSOR VIVIAN B. LEWES, "Liquid Fuel." Three Lectures.

January 20, 27, February 3.

CYRIL DAVENPORT, V.D., F.S.A., "The Art of Miniature Painting." Three Lectures.

February 10, 17, 24.

FRANCIS WILLIAM GOODENOUGH, "Coal Gas as a Fuel for Domestic Purposes." Two Lectures.

March 3, 10.

PROFESSOR JOSEPH ERNEST PETAVEL, M.Sc., F.R.S., "Aeronautics." Three Lectures.

March 31, April 7, 14.

DAVID SOMMERVILLE, B.A., M.D., M.R.C.P., D.P.H., "Antiseptics and Disinfectants." Three Lectures.

April 21, 28, May 5.

JUVENILE LECTURES.

Wednesday evenings, January 1 and 8, 1913, at 5 o'clock:—

CHERRY KEARTON, "Natural History." Illustrated by the cinematograph.

ADDRESS TO THE ROYAL SOCIETY.

At a meeting of the Council of the Society, held on Monday, November 4th, LORD SANDERSON, G.C.B., K.C.M.G., Chairman of the Council, presiding, the following address to the Royal Society on the occasion of the Two Hundred and Fiftieth Anniversary of its foundation was approved and ordered to be sealed:—

The Royal Society for the Encouragement of Arts, Manufactures and Commerce welcomes the opportunity which has been afforded to it of offering its warm congratulations and best wishes to the Royal Society on the Two Hundred and Fiftieth Anniversary of its foundation.

Among the many services which the Royal Society has rendered to this country, and to science in general, one—not the least—has been that, in proportion as the increase of knowledge has rendered necessary special and separate study of each branch of investigation, the Society has been instrumental in the formation of fresh associations for this purpose, while itself maintaining a general interest in the whole field of progress and discovery. The Society of Arts, in whose foundation a century and a half ago several Fellows of the Royal Society took a prominent part, has from its commencement looked to the Royal Society as the parent of such associations in this country, no less than the model for similar combinations abroad, and congratulates itself on the close connection between the two Societies which has been maintained throughout its existence by the presence in its ranks of many distinguished Fellows of the Royal Society. The Council have had pleasure in deputing their Chairman to represent them among the distinguished crowd of delegates who have come from all countries of the world to take part in the celebration of this auspicious anniversary, and they desire to express their earnest hope that the future may have in store for the first and greatest of English scientific societies achievements no less illustrious and beneficial to mankind than those which are recorded in its past history.

Sealed with the Seal of the Royal Society for the Encouragement of Arts, Manufactures and Commerce, in the presence of

SANDERSON, *Chairman of the Council*,
H. T. WOOD, *Secretary to the Society*.

November 4th, 1912.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Wednesday afternoon, the 6th inst. Present:—

Sir George Birdwood, K.C.I.E., C.S.I., LL.D., M.D. (in the chair), Sir Arundel T. Arundel, K.C.S.I., Sir M. M. Bhownaggree, K.C.I.E., Right Hon. Sir Henry Mortimer Durand, G.C.M.G., K.C.S.I., K.C.I.E., Sir Philip Perceval Hutchins, K.C.S.I., R. A. Leslie Moore, I.C.S. (Retired), Alexander Falconer Wallace, Sir James Wilson, K.C.S.I., Colonel Charles Edward Yate, C.S.I., C.M.G., M.P., with Sir Henry Trueman Wood, M.A. (Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Section).

CANTOR LECTURES.

The Cantor Lectures on "The Loom and Spindle: Past, Present and Future," by Mr. Luther Hooper, have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

OCEAN WAVES, SEA-BEACHES, AND SANDBANKS.

By Vaughan Cornish, D.Sc., F.R.G.S., F.G.S.

Lecture II.—Delivered January 29th, 1912.

On the Principles which Govern the Transportation of Sand and Shingle by Tides and Waves, with a Note on the Severn Bore.

Having embarked upon the study of sea waves in the year 1895, I presently found that, as far as related to deep-sea waves, a theoretical basis of knowledge had been securely laid by mathematicians, but that further observations and measurements were required. Bricks, as the saying is, cannot be made without straw, and the mathematicians had used up all the straw which had been provided for them.

In regard to the action of tides and waves in the transport and accumulation of detritus upon our coasts, I found on the contrary, that a large body of facts of observation were generally accepted (many of which I verified for myself), but that the explanations offered were various and contradictory. Thus it was known that on the south coast of England the shingle drifts, on the whole, up-channel, but this was by some explained on the supposition that the flood-tide current ran more swiftly than that of the ebb, whilst others held that it was due to the circumstance that westerly winds are more frequent, and generally cause larger waves, in the Channel than winds from the east.

Whilst, therefore, my contributions to the knowledge of deep-sea waves have been by way of obtaining fresh facts, which find their explanation in the received theory, my observations on our coasts have led me chiefly to a thinking-out of the proper explanation of facts already known. I have based myself throughout upon the well-established theory of wave-motion in water; but another kind of thinking had to be done at the same time—viz., on the effect of the rate of settlement of particles of different sizes through water, which leads to the separation of shingle and sand from one another.

I now proceed to set out shortly the principles which I consider govern the observed transport of detritus upon our shores.

On the proper action of Waves outside the Breaker Line to drive Sand and Shingle in the direction of their own advance.

The first principle which I desire to establish is that oscillating waves, apart from any motion of translation, have a specific action to drive sand and shingle in the direction of their own advance. When a beach has been piled to a certain steepness the back-slope counteracts this.

The case I take for explanation is that of waves travelling in water of a uniform depth (*see* Figure). As a matter of established theory, which it is easy to verify approximately by ordinary observation, the water-particles begin to rise as the trough passes. At the first node or shoulder the forward current sets in, the upward current continuing. As the crest passes the water begins to subside, the forward current continuing. As the second descending node or shoulder passes a backward current sets in, the water still subsiding, and it continues to subside until the trough is reached, when the upward movement once more commences, the backward current continuing. Thus the upward and downward movements of the water do not set in at the same time that the forward and backward currents respectively commence, but at intermediate times. Let us see how this peculiar succession of events affects the movement of the sand upon the bottom. Sand settles at a slow rate through water. Conversely, a moderate upward motion of the water is sufficient to suck it up from the bottom and maintain it in suspension. Thus, when the trough passes, and the upward movement of the water begins, sand is thrown into suspension. Consequently, when the forward current commences at the first or ascending node the water is charged with sand in suspension which is swept forward. The upward movement continues until the crest arrives, during which time more sand is continually being thrown into suspension. When the crest passes the water begins to subside, and no more sand is thrown into suspension, but that which is already suspended is still swept on by the forward current which continues until the second shoulder or node is reached; then the backward current commences; but the movement of the water being still downwards, no sand is now being thrown into suspension, and, moreover, some of that previously in suspension has again settled to the bottom. Thus, during the first half of the backward flow the water is being clarified; therefore the quantity of sand swept backwards is correspondingly less. The upward motion commencing as the trough passes, sand

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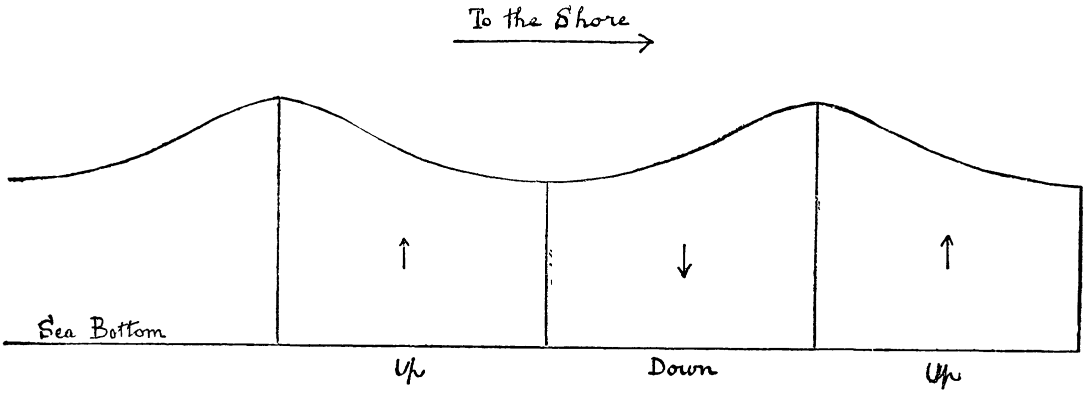
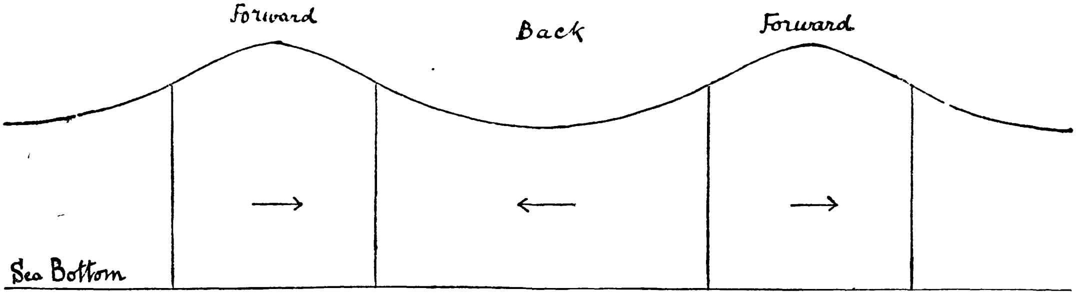
is once more churned up from the bottom, so that for the second half of its duration the backward current acts upon an increasing charge of sand, but this backward transport is much more than neutralised by the forward current, which, setting in at the ascending node, acts from the first upon water charged with suspended sand.

Thus the order of succession of the vertical and horizontal movements of wave-water secures a predominant forward movement to the sand when the water is sufficiently shallow for the waves to churn it up from the bottom. The differential effect upon shingle is similar but more marked on account of its more rapid subsidence. The stones are loosened from their anchorage by the upward movement of the water, and swept forward as the crest passes, but, except in very rough weather, they are again firmly anchored when the backward current commences at the descending node.

On the Action of Breakers to form a Beach.—The sand and shingle supplied to the breaker from behind are thrown forward and piled up in a ridge or beach. When the beach attains a certain steepness the reverse slope neutralises this action. The action on which beach-building depends is percolation. When a deluge of water is launched upon a heap of stones the liquid gradually sinks in and fills the cavities. Thus when the breaker flings water upon a beach the water returns by gravity, and the depth of the current which returns down the surface is less than that of the water which flowed up it. Thus by loss of buoyancy and by stranding beaches are built up. The action is more marked in shingle than in sand, first because percolation is quicker, and secondly because larger particles are more readily stranded. An exaggeration of the same effect is seen in the "wrack" or fringe of large and light objects, pieces of wood, shells, and so forth, which marks the furthest reach of the wash of the breakers upon a beach.





On the predominant Drift of Sand and Shingle in the Direction of the Flood Tide.—The influence of the tide upon the transport of the detritus which lies between low and high water-mark can only be understood by considering together the vertical and the horizontal movements of tide-water. The proportion of the horizontal to the vertical components is very different from that in wind-formed waves, but the order of their succession is the same; that, namely, which is the necessary accompaniment of the advance of a superficial wave under the action of

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gravity. When the tide advances freely, as in mid-channel, the movements are exactly as shown in the figure for wind-formed waves, but they are more easy to remember on account of the circumstance that the vertical and horizontal currents of the tide have familiar names. The upward current is called the Rise, the downward current the Fall, the forward current the Flood, the backward current the Ebb. Much confusion arises, however, from the neglect of students to keep this four-fold aspect of the tides clearly in mind. Where the tide flows freely, as it does approximately midway between shores at the entrance to the English Channel, it begins to flow at the ascending node, *i.e.*, when the level of the water is half-way between low and high, and continues to flow until the descending node is reached, *i.e.*, half-way between high and low water on the falling tide. Thus the flood tide is a current running up-channel from the time of mean sea-level of the rising water past the time of high water until the time of mean sea-level of the falling water.

Conversely, the ebb tide is a current running down-channel from the time of mean sea-level of the falling water past the time of low water until the time of mean sea-level of the rising water.

Past headlands and salient positions on the coast, the flood and ebb set in at nearly the same times relatively to the commencement of the rise and fall.

Therefore, in such situations most of the area between high and low water-mark is covered by the sea during most of the time of flood tide, *i.e.*, when the water is running up-channel, and all of it is covered during part of this time. Conversely, most of the area between high and low water is beyond the reach of the sea during most of the time of ebbing tide, and all of it during a part of that time. As, moreover, most of the beach material lies above mean sea-level, and the beach is thickest at the top, it follows that on promontories and salient positions the transport of detritus lying between high and low water is mainly achieved whilst the tide is flowing, *i.e.*, while the current is running up-channel.

The velocity of the tidal currents in fairly deep water off the coasts of Great Britain is known. Their velocity in the shallow water between low and high water-mark has not been made the subject of such detailed observations. That it is generally less than that a little further out is probable. That it is, however, often considerable is known from ordinary experience, When there is a rough sea upon a sandy shore, the water for some distance behind the breakers is turbid from particles of sand in permanent suspension, and these particles must drift a long way, sometimes probably miles, in the course of a single tide. It is evident, therefore, that whereas it is the waves which churn up the sand and place it in suspension, the tidal current must largely affect its longshore transportation. This is in accordance with the general opinion derived from observation. It follows, further, from what has been said above, that in salient positions the tidal drift of the sand between high and low water must be predominantly in the direction of the flood tide, because during ebb tide the material is to a great extent beyond the reach of the sea. For this reason the action of the flood tide upon sand will predominate, even if the velocity and duration of the flood and ebb be equal.

In bays and inlets the obstructing shore, accelerating the accumulation of an opposing head of water, makes high water earlier than it would otherwise be. The momentum of the flood current is by this opposition sooner exhausted, so that the ebb begins sooner after high water than it does off headlands. Thus in bays and inlets the difference between the flood and ebb in their power to transport sand is less than on headlands and salient positions. As the actual tidal transportation is simply the difference between the effects of flood and ebb, it follows that, apart from all other influences, there will be a tidal accumulation of sand in bays and inlets at the expense of headlands and salient positions.

There are also exceptional positions called tidal nodes where the tide begins to ebb almost at the same time as it begins to fall. A notable case is the line from a little west of Dungeness to the French coast, where the tide which comes up the English Channel opposes that from the North Sea. In such positions the resultant tidal transportation will be a minimum, unless any peculiar circumstance intervene, because the average water-level during ebb is nearly the same as during flood.

I am not able at present to lay down useful general principles for positions such as I suppose must exist where the ordinary backward and forward swing of flood and ebb is replaced by a horizontal circulation of water about a vertical axis. I have, however, dealt with a particular case, which is somewhat of this kind.*

* See "Waves of the Sea and other Water Waves," pp. 206–211: "On the Production and Maintenance of the Shambles Sandbank near Portland."

It remains for me to deal with the question —to what extent the tidal currents affect the littoral drift of shingle. It is not in dispute that the direction of this drift on the shores of England is generally in the direction of the flood tide, but it happens that in most exposed places on our coasts the flood tide comes from the same direction as the heaviest waves or the prevailing winds, or both. It is also not in dispute that the tidal currents on our coasts do not disturb the shingle when there are no waves. It is the waves which loosen the shingle from its anchorage on the bottom and keep it moving. The stones are generally only partially buoyed up by the churning action of the waves, and are at most only momentarily suspended.

The debated question is whether the longshore tidal current sweeps along the stones when in this loosened and lightened condition. Observations have been attempted, and opinions have been formed from them, but no one has yet produced observational evidence convincing to all persons who have given attention to the subject. I proceed to set forth the theoretical reasons which I consider show that in exposed positions, headlands and the like, the tidal currents do sweep the shingle along whenever waves beat upon the shore. Suppose the wind to be dead on-shore, and that there is no "swell," then the only breakers are those whose fronts are truly parallel with the shore.

First, take the time of slack tide. Suppose the breakers to beat upon bare shingle and the water falling thus from a height, but in an inclined direction, to have a horizontal velocity of five miles per hour. The shingle will be moved up and down the beach, but there will be no longshore drift, for the current will be at right angles to the shore. Next, let us suppose that there is throughout the narrow strip of water above low water mark a uniform longshore tidal current of one mile per hour. The differential movement of the sea-water which causes the breakers is still at right angles to the shore. But each particle of water which falls under the action of gravity from the breakers' crest starts with a lateral or longshore movement of one mile per hour. Its blow upon the shingle is, therefore, not delivered at right angles to the shore, but at an angle thereto, and thus the longshore drift of the shingle is produced. If the speed of the tidal current be greater the amount of this drift will be increased even though the waves remain as before. If waves come obliquely in the same general direction as the tidal current, the drift due to the differential, or wave, motion is increased by the current. If the current be against the waves the drift caused by them is correspondingly diminished. If throughout the year the oblique waves come equally from either hand, the whole resultant shingle drift will depend solely upon the amount of longshore tidal motion of the wave-water. I have pointed out that during the flowing tide more of the area between tide marks is covered by water than during the ebbing tide, and that this gives the flood tide a preponderance over the ebb in the transport of the *sand* which lies between tide-marks. But the shingle lies for the most part above mean sea-level, although there are local exceptions. Thus shingle drift in exposed positions goes on almost wholly during the hours of the flood tide. It follows, therefore, that with waves equally from both quarters the drift of the shingle will be in the direction of the flood tide. It equally follows that the observed drift in situations chiefly exposed to winds and waves from the same direction as the flood tide is partly due to that prevalence of wind and wave and partly to the current of the flood tide itself.

These conclusions differ from those of the Commissioners on Coast Erosion,* who are of opinion that the tidal currents increase the rate of longshore travel of shingle disturbed by waves, but do not, on the whole, determine or materially influence its direction, which they say "is governed" by that of the winds acting by means of the waves which they produce.

On the theoretical grounds already stated I consider the Commissioners to be mistaken. It may be objected that the Commissioners were influenced by the evidence of *observers.* I also have observed, and have found the observations extremely difficult. Once, however, I made an observation of some illustrative value which was clear and easy. It was on the banks of the River Spey—always rapid, and then swollen by melting snows. Small progressive waves came in upon a shelving bank of coarse sand, which under their small currents behaved as shingle, *i.e.*, moved about, but was not thrown into more than momentary suspension. One or two ridges of this coarse sand were formed parallel to the shore, and the on-and-off shore motion of the coarse sand grains could be seen as the wave currents swung to and fro. But all the time I could see how the current was causing a continuous drift of the sand grains parallel to the shore. The applicability of the observation

* Final Report, § 43 (2), pp. 12, 13.

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depends upon the fact already mentioned that the particles were not in suspension.

Waves are very deceptive to the eye. When standing on a tidal shore they monopolise the attention by their stately movement, by their resounding noise, and by the insistence of their rhythmic repetition; and all the while the tidal current flows by, silent, invisible, unnoticed, but steady, continuous, and persistent.

ON THE SEVERN BORE.

In a river the duration of the flood tide is less than that of the ebb. The backing-up of the land-water produces a "head" which reverses the current before its time, so to speak, and the contraction of the channel contributes to this effect. Conversely, the momentum of the land-water flowing down hill towards the sea enables the ebbing waters to continue flowing, so to speak, beyond their time.

The rise of tide in the Bristol Channel is very great, and causes the tide in the River Severn to extend beyond the summit of those miles of steep gradient which extend from the Shepherdine Sands to Hock Cliff. Between these places the permanent banks of the Severn have the funnel shape which is characteristic of a tidal estuary, and at high water the river has the estuarine appearance. Between the permanent banks, however, are great stretches of loose sand, and during most of the hours of ebbing tide the river follows a course through winding channels which it has incised in the sandbanks, this sinuous course having the characteristic form of a river channel in an alluvial plain.

In the lower part of the steep gradient, viz., between Shepherdine Sands and Severn Bridge, can be seen in the sands at low water dry channels, or swatchways, along chords of the semicircular arcs of the winding course of the ebbing stream. When the incoming waters of the flood tide here encounter the ebbing stream, they are by it pressed aside into these by-channels, which are filled by the incoming flood-water before the current in the ebb channel is reversed. Presently the water in the by-channel or swatchway, rising above the level of the intervening sandbank, sweeps across it in a broad sheet, and enters the ebb channel sideways. A short period of somewhat turbulent eddying ensues, after which the current is found to be up-stream, *i.e.*, the tide is flowing all across the river at the position in question. Higher up, however, much the same process is repeated at each bend of the winding ebb channel until Severn Bridge is reached. Above this place, there being a greater proportion of land-water and a smaller proportion of sea-water, the ebb channels are more deeply incised, and their banks being high, the waters of the incoming flood tide are confined between them until a sufficient head has accumulated to overcome the momentum of the ebbing water, and the front of the flood tide makes its way directly up the ebb channel. It does so usually in the form of a bore, a steep-fronted breaking wave 1 ft., 2 ft., or 3 ft. high, occasionally, perhaps, higher. Immediately after the bore has passed any spot the current, which until then was ebbing seawards, is found to be flowing swiftly up-stream. Such is the effect of the distribution of the sandbanks in determining whether a bore shall or shall not arise in an estuary where the steepness of the gradient, the shallowness of the water, and the greatness of the tidal rise, are favourable to its formation.

In dry seasons the waters of the flood tide rearrange the sandbanks so as to facilitate the rise, the tide making cut-off channels across the chords of the arc-like ebb channels, and avoiding the conflict of a wave by means of an easy circulation. Thus, after a dry summer, there are only small bores formed even in the great tides of the early autumn.

After a period of heavy rains, on the contrary, the sinuous ebb channels are so deeply incised that the flood tide has no alternative but to battle with the ebb, and when the high equinoctial tides follow a rainy season, great bores are formed.

I have referred in the preceding sections of the paper to the relation of my own wave observations of the last seventeen years to the established theory of water-waves. In the matter of deep-sea waves I have added new observations required to advance the subject on the lines of the theory. In the matter of littoral drift I have applied the same theory to the explanation of facts observed before my time and re-observed by myself.

Only in the matter of tidal bores, as illustrated by the Severn Bore, do I find that my observations show the necessity for a modification of the hitherto accepted theoretical treatment of waves. The tidal bore has always been treated as the steepened front of the whole tidal wave. In other words, it was said that the tide advanced up a river with a bore when the retardation was such as to make the first rise of the tide sufficiently sudden to form a high, steep face. Sir G. H. Darwin, however, had pointed out that the theory served rather to explain a rapid rise than an absolutely sudden one.

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Now, if the theory had been correct, the length of the wave of which the bore was supposed to be the face or front slope would be many miles. Consequently, in the case of the Severn, for instance, the wave-length would be indefinitely great as compared with the depth at low water. Consequently the only change of appearance of the bore in passing from the shallows to the pools of the river between Newnham and Gloucester would be that in the pools the speed would be greater and the height less.

I have observed, however, on more than one occasion, and in more than one place, that this is not at all what happens. The bore advances across a rocky shoal, such as Denny Rock, with a steep, breaking front, and, at all events when seen from a low standpoint in front, appears to be a solitary wave; but, when it passes into the pool beyond, the steep front disappears, and the breaking, solitary, or almost solitary, wave is replaced by a rounded billow which multiplies itself to leeward, a group of as many as sixteen such waves being rapidly formed. Thus it appears that the disturbance which constitutes a bore in the Severn has a wave-length long, perhaps, as compared to the depth of water at low tide in the shallows, but certainly short as compared to the depth of water in the pools.

Observation shows that the rise of a tide is never perfectly steady, but is pulsative in time and, therefore, undulatory in space. I think that a bore in the Severn is the steepened front of any one such local swelling of the tide caused by local resistances. I have described elsewhere* how at Hock Cliff more than one bore can be seen running at the same time in different channels, and even in different directions, up-stream, down-stream, and laterally.

* "Waves of the Sea and other Water Waves," p. 246.

THE MANUFACTURE OF GLASS CHRISTMAS-TREE ORNAMENTS IN GERMANY.

The acknowledged German centre of the glass Christmas-tree ornament industry is in the Thuringian Mountains, twenty-five miles distant from Coburg, where almost the entire population is dependent upon this industry. It is here that Christmas is really appreciated, and man, wife, and children work uninterruptedly, even the smallest children helping as soon as they can use their hands. In the small village of Lauscha, at the end of the branch railway line running from Coburg, the largest quantities of the glittering Christmas-tree ornaments are made. The processes of manufacture, which are not only instructive and interesting, but also unique, according to the American Vice-Consul at Coburg, are as follows. Fine glass-blowing is done in every house and hut, and the majority of the inhabitants who work on these articles show great talent and dexterity in producing the delicate fragile balls, stars, etc. The glass tubes are bought by the inhabitants from a local glass factory, being either of thick or thin glass, according to the kind of article to be produced. To blow the various ornaments, these tubes are held over the flame of a gas blow-pipe, with a bellows worked by the foot. The tubes are in this manner heated to a point where they become soft, and a light "puff of breath" is then sufficient to expand the glass mass, although the blower must calculate the pressure of air to be blown into the tube with care and dexterity, as otherwise the glass immediately assumes a much larger size than that desired. The professional blowers understand how to give the mass of glass every possible form simply by blowing and pulling. They make animals of every description, a speciality of theirs being reindeer, with their delicate legs and huge antlers. Then there are airships and balloons, while the commoner glass Christmas-tree ornaments, known to every child, are made in profusion. Perhaps the most difficult article made is the imitation carnation or rose, where every individual petal has to be formed separately and then attached to the body. This is done by heat, the various parts being fused on, as is also the case when the bodies of animals have their legs, ears, and all other protruding parts attached. Although the glass article is then finished, it has a very lifeless, disappointing look, and cannot be sold till the necessary "charm and grace" are given by means of colour. All the beauty of the light glass article is brought out by the shining, sparkling colour. The glass-blower, however, does not attend to this branch of manufacture, because highly-coloured glass is very seldom used, for the simple reason that it is too expensive. The colouring of the glass ornaments is generally attended to by women and children. When a finer article is desired it is given to more artistic workers, who understand how to use a brush. Glass balls are painted with rings or other designs, and the other articles are also decorated with a brush. The common round glass balls which are used to decorate the Christmas tree, either singly or strung together in chains, are usually coloured on the inside. This is done either by dipping the article in a thin, cheap, colouring liquid, or gold and silver bronze in a liquid state is poured into the interior. In this manner gold and silver balls are obtained which look pretty and keep their colour a long time, but which, on the other hand, break at the least pressure. Colouring by simply dipping the glass article in a liquid colour is a very easy, mechanical work, which is mostly done by small children. A great deal of care must be taken in packing glass ornaments, as otherwise, on arrival

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at their destination, the cases would be found full of nothing but thin, sharp pieces of broken glass. Cardboard boxes, divided into twelve compartments, are used, and the glass ornaments, which are sold per dozen, are laid in very light, cheap, cotton batting, which lightens the pressure and prevents rattling, thus protecting the contents. The goods must, of course, be offered as cheaply as possible to ensure large sales, for otherwise the profit to the middleman and merchant would be too small after payment of freight and duty. Consequently the profit of the producer is small; but, as his tastes are simple, the small amount earned looks quite respectable in his eyes. These Christmas-tree ornaments weigh so very little that they are, as a rule, sent to their destination by parcels post instead of being shipped by rail. From the middle of November each year up to Christmas Eve, the number of packages of Christmas-tree ornaments passing through Coburg from Lauscha and the other mountain towns, is so large that not only extra men are needed at the post offices, but also additional carriages have to be attached to every train.

TRANSIT OF SHIPPING VIA THE SUEZ CANAL.

During the first six months of the present year the total number of vessels that passed through the Suez Canal was 3,314, of these 2,825 were steamers and 489 sailing ships, with a total aggregate tonnage of 10,511,618. The total receipts for the transit of these vessels was 70,204,000 francs (£2,808,160) as compared with 68,058,000 francs (£2,722,320) during the corresponding period of 1911, an increase of 2,146,000 francs (£85,840) in favour of this year, notwithstanding the reduction of the dues since January 1st and the coal strike in England of last spring. The following shows the number, tonnage, and percentage of the vessels of the six principal nations in order of importance—

Nationality.	No. of vessels.	Tonnage.	Percentage of total tonnage.
British	1,769	6,668,445	63·43
German	351	1,517,951	14·44
Dutch	171	619,106	5·88
Austro-Hungarian	156	506,852	4·81
French	110	396,887	3·77
Italian	77	195,620	1·85

The remainder, belonging to ten different countries, follow in order of importance—Russia, Japan, Sweden, Denmark, Norway, Spain, Greece, Siam, United States, and China.

The total number of passengers, including troops, carried by these vessels has fallen from 148,955 during the first half of 1911 to 115,177 for the same period during the present year.

The following were the numbers and nationalities of the troops that passed through the canal during these periods each year—

	1911.	1912.
Italian	574	3,514
Turkish	37,899	33
British	12,243	1,338
German	5,475	5,366
French	5,652	5,361
Dutch	890	735

THE SHIPPING AND FISHING INDUSTRIES OF BERGEN.

A report of the Italian Consul at Bergen (Norway) gives some interesting information respecting the shipping and fishing trade at that town. At December 31st, 1911, the merchant fleet of Bergen consisted of 216 cargo steamers, registering a total of 380,000 tons; five sailing vessels, 7,200 tons; and 86 passenger steamers, 40,700 tons; in all, 307 ships with an aggregate tonnage of 427,900. There were, at the same date, six cargo and one passenger steamer in construction. In addition, there were 39 steam launches and motor-boats belonging to the port.

This fleet is owned by seventeen navigation companies and forty-seven private firms, and represents a capital of 84 million kroners * (£4,725,000). The crews number upwards of 6,000 hands.

A company was formed, last year, at Bergen for carrying on whale fishery on the North American coast. It now possesses a steamer of 2,197 tons and four fishing boats to the value of 800,000 kroners (£45,000).

The fishing industry is a very important branch of trade at this port. Last year the sale of dry and salt cod, as well as of cod-liver oil, was less remunerative than usual on account of the high price paid for the fish at the opening of the season; and the abundance of it at the close. The fish-canning industry gave better results last year than previously.

On the whole, the fishing season generally, last year, of Norway may be considered to have been a more profitable one than that of 1910, but the statistics for 1911 are not yet available. The value of the products of the cod fishery, which besides dried and salt fish includes cod-liver oil and cods' roe, amounted last year to 19,200,000

* Norwegian kroner = 1*s.* 1½*d.*

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kroner (£1,080,000). The herring and other fisheries on the coasts of Norway and Iceland produced 47,300,000 kroner (£2,606,625).

The fishing industry gave employment to 89,926 persons and 18,940 boats in 1910.

With regard to the trade between Italy and Bergen, the exports from this port in 1911 consisted chiefly of 7,444 metric tons (7,326 English tons) dried cod (stock fish); 466 metric tons (458 English tons) salted cod; 1,862 barrels cod-liver oil, and 2,700 kilogs (53 cwt.) preserved fish.

The exports from Italy to Bergen during the same period were chiefly salt and wine. Of a total of 46,458 metric tons of salt imported to this port, Italy figures for 19,557 metric tons (19,249 English tons).

With regard to wine, only 9,000 litres (1,980 English gallons) of Italian growth were imported, as compared with 125,000 litres (27,500 gallons) from Spain, 359,000 litres (78,980 gallons) from Madeira, 152,000 litres (33,440 gallons) from Greece, and 33,000 litres (8,560 gallons) from France.

EMPIRE NOTES.

Canadian Canals.—Water transport is every year increasing in volume in the Dominion, and the systematic development of canals, linking up in a chain the great lakes, is proving an important factor in the distribution of produce and merchandise. The Canadian Railways and Canals Department returns show that the traffic passing through the canals has increased from 17½ million tons in 1908 to 38 million tons in 1911, *i.e.*, it has more than doubled in three years. By far the greater proportion of this tonnage, however, originates in the United States, and millions of tons of iron ore find their way annually through the canal at Saulte St. Marie, from Lake Superior, for the United States black furnaces.

Panama Canal.—Western Canadians are busily preparing for the opening of the Panama Canal, and a company has been formed, under the title of the British Canadian Transport Company, for the purposes of running a regular service of steamers from New Westminster, B.C., to British ports. The congestion of freight, both upon the railways and the existing steamship lines, is a serious matter, and the opening of this new trade route is being eagerly anticipated by the whole western community.

Pulpwood.—The quantity of pulpwood manufactured in Canada in 1911 showed an increase of 73,801 cords (or 12·3 per cent.) over that of 1910. The rise in market values of this product has brought the industry a much greater return in money than the increase in output denotes. The value of the wood returns for 1910 was $3,585,154, and in 1911, $4,338,024, or a net increase of $752,870. The average price of $6·45 per cord secured by the vendors in 1911 is nearly a record, and has not been equalled for years. Considerable attention is being drawn to the vast supplies of available timber in Quebec, and some important developments may be looked for in this Province in the near future.

Australia's New Capital.—The Commonwealth is starting operations on the city water scheme, and it is estimated by the engineers that a sum of £90,000 will have to be expended on the construction of the Cotter River dam. It is not anticipated that more than £9,000 for this purpose will be spent during the present financial year. Tenders are to be called for at an early date, for the laying of a cast-iron main from the site of the dam to the service reservoir, a distance of ten miles. This will probably entail a further outlay of £50,000 to £60,000.

Visit of British Association to Australia.—Australians are preparing for the reception of the 200 to 300 members of the British Association who will visit them from all parts of the Empire in 1914, and the Federal Government has already subscribed £15,000 towards the expenses. The programme of this visit is in the hands of the various scientific bodies throughout Australia. This will be the fifth meeting of the Association held outside the United Kingdom, as the Association has visited Canada on three occasions and South Africa once. The meetings in the various overseas Dominions have been productive of splendid results, not only from a scientific, but from an Imperial point of view, and the congress to be held in Australia is not likely to be an exception. The visitors will find much to interest them, and their tour is sure to prove of value as a stimulant to the useful scientific research that is at present being carried on by different societies throughout that continent. The meetings will be held in Sydney and Melbourne, and special arrangements are being made for an inspection of the Great Barrier Reef, and a steamer will be placed at the disposal of the delegates for this purpose. The party will also visit the north coast and study some of the problems of the northern territory.

Growth of Manufactories in New South Wales.—The Secretary of the Sydney Chamber of Commerce, Mr. J. Maitland Paxton, has recently been visiting London, and in the course of an interview gave some interesting and instructive details concerning the progress of New South Wales' industries. After touching on the principal industries, such as the production of wool, wheat, dairy produce, etc., he dealt with manufactures. According to Mr. Paxton, the value of land and buildings used solely for industrial purposes, at the close of 1909, throughout the Commonwealth was £27,677,595, of which £11,014,362 was the share of New South

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Wales and £8,642,344 that of Victoria. Mr. Paxton expressed the opinion that the cost of labour in the Commonwealth would preclude, to a large extent, Australian manufacturers from the export market, and considers that they will have to look to the home market for support. The flour mills, according to the same authority, are well equipped and have an output value of £6,000,000 per annum. Another very prosperous industry is the manufacture of agricultural machinery, and this machinery is finding a ready sale in the Argentine, as well as at home. Mr. Paxton echoes the cry for labour, and points out that this need is handicapping the output of many manufactories.

Irrigation in Australia.—Western Australia is following the example set by Victoria and New South Wales, and is seriously turning its attention to the conservation of water during the wet months for distribution during the dry. A bill has just been prepared, and will shortly be submitted to the State Parliament, conferring upon the Minister for Water Supply power to acquire land for irrigation purposes, and to grade, subdivide, and lease it for closer settlement. Already Parliamentary powers have been obtained for the construction of a reservoir near Harvey, one of the finest orange-growing areas in Australia. This reservoir will hold 350 million gallons of water, and will cover an area of 77 acres. This will be the first of several similar projects to be carried out in Western Australia. The Minister of Works, before a large number of visitors, performed the ceremony of opening the sluices at Yancs, and letting the water for irrigation purposes on to the Burrinjuck land. This water has been brought from the Murrumbidgee, a distance of 220 miles. The reservoir in the mountains, where the supply of water is stored, has a capacity of 33 billion cubic feet of water, a volume greater than that of Sydney Harbour itself. The catchment area supplying this water extends over 5,000 square miles. Arrangements are already completed for irrigating 358,000 acres on the north side, and, later on, a large acreage to the south will be served. The authorities estimate that this scheme will ultimately enable 100,000 new settlers to secure profitable holdings, and nearly all the farms in the first sub-division have already been applied for. The capacity of the district for fruit-growing has been tested by the State Government, and for some time past an experimental farm has been operating in the centre of the district. Settlers will be able to secure useful data from the investigations and experiments carried out at the institution.

New Zealand Fisheries.—Those interested in the New Zealand fisheries will watch with interest an experiment which is to be carried out there. The Portobello (N.Z.) Maine Fish Hatchery Board has decided to send their curator, Mr. Anderton, to England, to bring out a shipment of herring ova. Mr. Anderton will visit a number of hatcheries in Great Britain, and will also proceed to Norway, Heligoland, and establishments on the Dutch, Belgian, and northern French coasts. A large stock of lobsters and crabs will be taken out as well, and an attempt will be made to introduce such fish as turbot, haddock, and cod.

New Zealand Butter.—The reports on the quality of New Zealand butter are very satisfactory. For some time California has imported it, and the merchants state that the quality of the butter is so good that it sells evenly with the best Californian production. But this New Zealand product is also making its way in Western Canada, where it bids fair to hold the same position as it does in California. The retail price in Western Canada is 1*s.* 8*d.* per lb.

Ostriches in the Transvaal.—Ostrich farming in the Olifants district of the Transvaal is showing up satisfactorily. Chicks purchased two and a half years ago have developed so well, that the feathers are fetching as much as £20 per pound weight. Quite recently a supply of these feathers was sent to Pretoria for the purpose of exhibition, and expert opinion was to the effect that the Olifants district is producing feathers equal in quality to the very best in South Africa.

Malay States Trade Progress.—A recent report on trade progress in the Malay States shows a steady increase in trade and customs receipts. The population has increased, and the extension of rubber plantations has been a help in this direction. The high price of tin also has contributed to the growth of prosperity, tin being one of the staple products of the peninsula. There has been a considerable increase in the imports of articles of luxury, such as tobacco, cigars, etc., as well as in articles of necessity.

NOTES ON BOOKS.

When Kings Rode to Delhi. By Gabrielle Festing. Edinburgh and London: William Blackwood & Sons. 7*s.* 6*d.* net.

The accomplished authoress of "On the Distaff Side," and "John Hookham Frere and his Friends," needs no introduction from me to the readers of the *Journal* of the Royal Society of Arts of her "When Kings Rode to Delhi"; and, besides, it was but a few weeks ago that, in a paper on "The Rajputs in the History of Hindustan," the *Journal* gave what was in effect a review of Miss Festing's "From the Land of Princes," to which her present volume is a most acceptable and most commendable supplement. The two volumes cover the same period and the same leading current of events; but, whereas the former deals with the Rajput protagonists in that bleeding controversy of over eight centuries, the latter treats of the chief Islamite [Turkman, Afghan, and Mo(n)gol] actors

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in it; and, again, only in its more heroical, and romantic, and tragical aspects.

There is no continuous Indian history before the Arab conquest of Sindh, A.D. 664–750; and the first assured date in it is that of Alexander's invasion, 327 B.C., "in the month of April," when he defeated "Porus" on the very ground whereon, 2,286 years afterwards, Lord Gough, and Sir Joseph Thackwell, and Sir Walter Raleigh Gilbert gained the decisive battle of Gujerat over the formidable theocracy of the Sikh Khālsā. Although in "From the Land of Princes" the selected legends and traditions of the Rajputs are arranged in the chronological order of the times to which they relate, they were not, and indeed the older of them could not be, systematically dated, and it adds to the value of "When Kings Rode to Delhi," as an introduction to Indian history, or rather the history of Hindustán—after the manner of Scott's "Tales of a Grandfather" to that of Scotland—that each of its successive chapters is headed with the inclusive dates of the incidents it records. But a still firmer grasp of the chronology of the often highly confusing circumstances of the centuries of Islamitic supremacy in Hindustan would have been secured by prefixing to Miss Gabrielle Festing's chapters a synoptical table, on one page, of the leading dates of the whole millennium over which they extend; and I venture to suggest this being done whenever a second edition of this most instructive and inviting volume is in preparation. We may assume about a millennium prior to Alexander's apparition at Attock, during which the aggressive Aryas and non-Aryas of India were more or less closely consolidated into the theocratical race of Brahmanical Hindus, as distinguished from the outcasts of the autochthons of the country, who, during the later centuries of this millennium, became the chief support of the Buddhist [economico-commercial] reaction against the Brahmans. The second millennium runs from Alexander to the invasion of Sindh by the Arabs; and the third [the first that is truly historical], on to the consolidation of the revindication of Aryan supremacy in India, as a consequence of the Sepoy Mutiny of 1857. The tabular statement of this last millennium may be sufficiently given as follows:—

THE ARABS IN SINDH. A.D. 664–750.

THE GHAZNIVIDS [Sabaktegin, "Mahmud of Ghazni," etc.] IN INDÍA. A.D. 978–1118.

THE GHORIANS. A.D. 1153–1206.

THE SLAVE KINGS OF DELHI [invasion of Mo(n)gols, 1217]. A.D. 1206–1288.

THE HOUSE OF KHILJI [Tartars]. A.D. 1288–1321.

THE HOUSE OF TUGHLAK [Tamerlane at Delhi, 1398]. A.D. 1321–1412.

THE SEIADS. A.D. 1412–1450.

THE HOUSE OF LODI [Vasco da Gama at Calicut, 1498]. A.D. 1450–1526.

THE MO(N)GOL EMPERORS [Sir Thomas Roe at Delhi, 1615–1618; Resurrection of the Mahrattas, 1707–1712; Invasion of Nadir Shah, 1738–9, of the Abdalli 1756; Plassey, 1757], A.D. 1526–1857.

That table is readily learned by heart; and it is a clue to the whole of the political history of India; the history of the Deccan being a mere fringe to the history of Hindustan; one might almost say of the pre-"eminent" city of Delhi.

It is needless for me to say anything more in praise of Miss Festing's volume, than that I have read it through, simply because having begun with it, I could not stop reading on and on, until I had ended with it. Only on one point do I seriously disagree with her, and that is in her unreserved condemnation of Humayun, the second Mo(n)gol Emperor of Delhi. He was not a great emperor like Baber, and Akbar, and Jehanghir, Shah Jehan, and Aurungib, but he was a brave and most chivalrous soldier, and one of the most loveable of men; and the idol of his father; who when, at one time, Humayun lay sick unto death, coming to the bedside of his son, passionately and vehemently supplicated, and implored the Almighty to take his life in sacrifice for Humayun's. After a while he cried out—"My prayer has been heard. I have borne it away," and from that moment the youth recovered, and Baber sickened and died, on December 26th, 1530. Miss Festing must help to give this true story of paternal affection and piety—and one of the most remarkable of the efficacy of prayer—a wider perusal in the next edition in this her most fascinating record of the lives and deaths of Turkman, Tartar, and Mo(n)gol kings, who from century to century rode right royally, in all the barbaric pageantry of High Asia, backward and forward between Khorasan, and Ghazni, and Cabul, and Kanouj, and Delhi.

I must quote some of the paragraphs from Miss Festing's "Epilogue" at length. Referring to the depravations of the Mahrattas and Rohillas she writes:—"Hindustan was gradually becoming depopulated at the close of the 18th century, and communication between the few villages that still existed was frequently cut off by the wild beasts that infested the highways. *Save in Rajputana, scarcely any reigning family in India could boast more than twenty-five years of independent and definite political existence.* All over the land Hindu and Muslim looked with longing to the one power strong enough to quench all these disorders and give peace in their time. 'The goodness of the English is beyond all bounds,' wrote a Muslim chronicler, about the year 1764, 'and it is on account of their own and their servants' honesty that they are so fortunate and wealthy.' 'They are a wonderful nation, endowed with equity and justice,' writes another a few years later. 'May they always be happy, and continue to administer justice.' 'When will you take this country?' a fakir asked Mountstuart Elphinstone in 1801. 'The country wants you. The Hindus [he meant the marauding Mahrattas] are villains. When will you take the country?' It was a question asked over and over again; but even after the battle of Buxar [1764] had settled the fate of Bengal, and the storming of Seringapatam [1799] had made it possible to effect the pacification of

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Southern India, and the Treaty of Basain had decided that the Maratha Confederacy was no longer to spoil and ravage a distracted country, no new ruler was yet proclaimed in Delhi . . . It was in September, 1857, that the Sappers and Miners opened the Kashmir Gate, and the last of the sons of Timur ceased to reign, even in name. It was in December, 1911, that the English King showed himself to the crowds who thronged the city, upon the wall where the Moghul Emperors were wont to stand, and once more made Delhi [the 'Eminent'] the chief city in India, as in the days of old."

Nothing can be more true, more just, more illuminating, than these few simple words, "ab imo pectore"; and nothing more moving and devoutly stimulating.

The printers, and binders, and the publishers have all done their best with the general get-up of the volume; which is illustrated with several colour prints reproduced from Oriental originals; and is bound in green [I hope intentionally], the colour of Islam; even as the volume of "From the Land of Princes" was appropriately bound in Rajput blue. It is only a pity, in this connection, that the two volumes should be of different sizes. It is always distressing to see on one's bookshelves books by the same author of different sizes; and the mistake of it often checks a purchase.

George Birdwood.

A Home-Help in Canada. By Ella C. Sykes. London: Smith, Elder & Co. 6s. net.

At a time when the tide of emigration is flowing so strongly in the direction of Canada, and when the question of sending out women to settle in our colonies is so much to the fore, the appearance of Miss Sykes's volume is very opportune. A patriotic believer in the greatness of the British Empire, Miss Sykes determined to go out and see for herself what are the openings for educated women in the Dominion, and with a view to making her test as practical as possible, she spent six months in various positions as "temporary home-help." The present volume contains an account of her experiences, which were mostly obtained in Western Canada. Upon the whole, and in spite of a glowing enthusiasm for the task of empire-building, it cannot be said that Miss Sykes views the prospects for women, and especially educated women, through rose-coloured glasses. Canada—at all events, those parts in which she stayed—is a land of ceaseless toil. The men work as long as there is any light to see by, only pausing three or four times a day to devour enormous meals; the women slave as hard, or even harder, with this difference, that while the men are for the most part out in the glorious air of the prairie, the women are cooped up in stuffy houses, and still more stuffy kitchens. Of course, in a country where there are a dozen or more men to every woman, almost every girl can get married if she likes; but marriage on the prairie is not quite the catch that it may seem to be to the superfluous woman in England. One of Miss Sykes's employers assured her that, though on the best of terms with her husband, she would never have married him had she known what her life would be. "I haven't a good word to say for the prairie, and I got to hate the very sight of a man, because a man meant preparing a meal. Our ranch was on a main trail, and man after man, as he came along, would drop in and ask for food as a matter of course, and very seldom did he give me a word of thanks for it." In reply to Miss Sykes's question, "But aren't there some women who love the life? In England we hear so much of the 'call of the prairie,'" the mistress replied, "There may be some, but I never met them. All my friends hated the loneliness and the lack of amusement, and the same dull round day after day."

It may be urged against Miss Sykes's criticisms that she found the work so hard because she was totally untrained for it, and, moreover, the better situations were not open to her because she merely applied for temporary posts. Her views, however, are not based upon her personal experience only; she talked with a large number of people in Canada, and she found that, speaking generally, the women on the prairie were worn and old before their time.

In spite, however, of all these drawbacks, Miss Sykes found much to compensate for them. She met with kindness from almost everyone with whom she came in contact, and she came to the conclusion that for the young, efficient and adaptable girl, Canada offers opportunities that are not to be had in the old country. But she must be prepared to work and to work exceedingly hard. "The girl who is a failure in Great Britain will most certainly not be a success in the Dominion."

GENERAL NOTES.

The Turkish Silk Industry.—Brusa and Beirut are the chief centres of the silk industry in Turkey, and the gross annual production of fresh cocoons in the Empire may be estimated at 33,000,000 lbs., valued at about £1,875,000. From 80 to 85 per cent. of this is spun in Turkey, the rest being exported to Continental markets. The spun silks are almost entirely exported, as the native looms are limited to a few hand machines. The average annual silk thread exports amount to about 1,100,000 pounds from Syria, and 1,540,000 pounds from Brusa and Adrianople. Turkey's 1911 silk crop was excellent, but prices were low, partly owing to the new fashions requiring less material, and partly on account of Japanese competition. Bona fide efforts are still being made to open up direct connections with the United States for the sale of Turkish raw silk. Merchants engaged in the silk industry in Turkey have had to face several poor seasons in succession, and there is a tendency to abandon silk for tobacco in some places.

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THE U.S.A. HARVEST.—The U.S.A. Government report, issued last week, shows that the harvest this year has surpassed all records. The results compared with last year are as follows:—

	1912.	1911.
Wheat, bushels . .	720,000,000	620,000,000
Corn ,, . .	3,016,000,000	2,531,000,000
Oats ,, . .	1,417,000,000	922,000,000
Rye ,, . .	35,000,000	33,000,000
Barley ,, . .	224,000,000	160,000,000
Potatoes ,, . .	401,000,000	292,000,000
Hay, tons. . . .	72,425,000	55,000,000

Not only are these crops the largest on record, but in most cases, what is highly important, quality is exceptionally good. "It should also be noted," writes Dr. Henry Clews, "that the fruit crops as a whole have been unusually abundant. All food products derived from plant life should be relatively cheap this year, and aid materially in keeping down the cost of living. Only meats are likely to be dear, since the supply of these has been actually declining. If the cost of living is to be reduced, it can only be accomplished by larger product and less waste both of materials and labour. Estimates now place the value of agricultural products this year as high as $10,000,000,000. Possibly this figure is excessive, but it is safe to say our farmers will produce at least $500,000,000 more than last year. With such a marvellous increase in the bounty of Nature, it will be impossible to prevent an active fall and winter trade."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 11...Post Office Electrical Engineers, Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 5 p.m. Mr. C. E. Hay, "Alternate Current Measurement, with special reference to Telephone Cables, Loading Coils, and the Construction of Non-reactive Resistances."

Brewing, Institute of (London Section), Criterion Restaurant, Piccadilly, W., 8 p.m. Messrs. Julian L. Baker, F. E. Day, and H. F. E. Hulton, "A Study of the Organisms Causing Ropiness in Beer and Wort."

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, the Hon. E. G. Strutt.

British Academy, in the Theatre, Burlington-gardens, W., 5 p.m. (Schweich Lectures.) Rev. C. H. W. Johns, "The Laws of Israel and Babylon." (Lecture II.)

Architectural Association, 18, Tufton-street, S.W., 8 p.m. Mr. J. A. Marshall, "Marbles used in Greek, Roman, and Byzantine Buildings."

Mechanical Engineers, Institution of, Storey's-gate, S.W., 8 p.m. (Graduates' Section.) Mr. G. L. Temple, "Standard and Racing Motor Engines."

TUESDAY, NOVEMBER 12...Sociological, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. Dr. A. K. Coomaraswamy, "Sati: A Vindication of the Indian Woman."

Asiatic, 22, Albemarle-street, W., 4 p.m. Mr. F. Legge, "Western Manichæism, and the Recent Discoveries at Turfan."

Civil Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. 1. Mr. B. H. Blyth, jun., "The Construction of the New Dock at Methil." 2. Mr. W. Cleaver, "Alterations and Improvements of the Port Talbot Docks and Railway during the Last Decade."

Zoological, Regent's Park, N.W., 8.30 p.m. 1. Mr. H. R. Hogg, "Some Falkland Island Spiders." 2. Mr. B. F. Cummings, "On some Points in the Anatomy of the Mouth-parts of the Mallophaga." 3. Mr. F. F. Laidlaw, "Contributions to a Study of the Dragonfly Fauna of Borneo. Part I.—The Corduliinæ: the Genus *Amphicnemis*." 4. Drs. H. L. Jameson and W. Nicoll, "On some Parasites of the Scoter Duck (*Œdemia nigra*) and their Relation to the Pearl-inducing Trematode in the Edible Mussel (*Mytilus edulis*)." 5. Mr. G. A. Boulenger, "Descriptions of Three New Fishes Discovered in the Gold Coast by Dr. H. G. F. Spurrell."

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 8.30 p.m. Hon. G. E. Foster, "Some Problems of Empire."

Phamaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. T. E Wallis, "Calcium Tartrate and Oxalate from Senna Leaves." 2. Mr. A. N. D. Pullen, "Note on Iodine Ointment."

WEDNESDAY, NOVEMBER 13...Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. L. W. King, "Some Unpublished Rock-Inscriptions and Rock-carvings in Turkish Turkestan."

Japan Society, 20, Hanover Square, W., 8.30 p.m. Mr. W. Crewdson, "The Textiles of Old Japan."

Automobile Engineers, Institution of, at the Imperial College of Science, South Kensington, S.W., 8 p.m. Professor W. Watson and Mr. H. Schofield, "Tests of a Daimler Sleeve Valve Engine."

Aeronautical Society, at the United Service Institution, Whitehall, S.W., 8.30 p.m. Mr. A. E. Berriman, "Aeroplanes in the Light of the Military Trials."

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 7 p.m. Annual Meeting, 8 p.m. Mr. A. H. Tyler, "The Application of CO_2 to Refrigeration."

British Academy, in the Theatre, Burlington-gardens, W., 5 p.m. (Schweich Lectures.) Rev. C. H. W. Johns, "The Laws of Israel and Babylon." (Lecture III.)

THURSDAY, NOVEMBER 14...Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Inaugural Address by the President, Mr. E. P. Wells.

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. T. G. Longstaffe, "Views taken in the Himalayas.'

Optical Society, in the Rooms of the Chemical Society, Burlington House, W., 8 p.m. Dr. Max Coque, "The Production of Light by Living Beings."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Opening Address by the President, Mr. W. Duddell.

Colonial Institute, Whitehall Rooms, Whitehall-place, S.W., 4.30 p.m. Mr. F. Williams Taylor, "Canadian Loans in London."

FRIDAY, NOVEMBER 15...Geographical Society, Queen's Hall, Langham-place, W., 8.45 p.m. Captain Roald Amundsen, "The Norwegian South Polar Expedition."

Child Study Society, 90, Buckingham Palace-road, S.W., 7.30 p.m. Madame Pujol Ségalas, "Maria Montessori's Method of Self-Education."

SATURDAY, NOVEMBER 16...Child Study Society, 90, Buckingham Palace-road, S.W., 3 p.m. Conference on the Montessori System.

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Journal of the Royal Society of Arts.

No. 3,130. VOL. LX.

FRIDAY, NOVEMBER 15, 1912.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Fifty-Ninth Session will be held on Wednesday evening, November 20th, when an address will be delivered by LORD SANDERSON, G.C.B., K.C.M.G., Vice-President and Chairman of the Council. The chair will be taken at Eight o'clock.

The following arrangements have been made for meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock:—

NOVEMBER 27. — HAROLD COX, "Political Economy as a Code of Life." SIR GEORGE RANKEN ASKWITH, K.C.B., K.C., will preside.

DECEMBER 4.—A. ZIMMERMANN, "The Manufacture of Sugar from Wood, and its Economic Importance." THOMAS TYRER, F.I.C., F.C.S., will preside.

DECEMBER 11. — DR. F. MOLLWO PERKIN, "Natural and Synthetic Rubber." ROBERT KAYE GRAY, M.I.E.E., will preside.

DECEMBER 18.—JOSEPH PENNELL, "The Pictorial Possibilities of Work."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 o'clock:—

NOVEMBER 26.—PROFESSOR W. H. WARREN, LL.D., M.Inst.C.E., M.Am.Soc.C.E., "The Hardwood Timbers of New South Wales." The RIGHT HON. SIR GEORGE HOUSTOUN REID, G.C.M.G., D.C.L., K.C., High Commissioner for Australia, will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 o'clock:—

DECEMBER 12. — SIR BRADFORD LESLIE, K.C.I.E., "Delhi, the Metropolis of India."

CANTOR LECTURES.

Monday evenings, at 8 o'clock:—

CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "Methods of Economising Heat." Three Lectures.

December 2, 9, 16.

EXAMINATIONS, 1912.

The Council of the Society have long looked forward to a time when the whole local control of the examinations should be in the hands of the Local Education Authorities. That such a consummation should be attained is but reasonable, seeing that these authorities are the final outcome of the system on behalf of which the Society did its pioneer work now sixty years ago. It was through the Society's organisation that the various mechanics' institutions, which had grown up in the second quarter of the nineteenth century, were systematised and brought into harmonious working. It was the educational centres thus established that provided means for the provision of local science and art schools, and it was the influence and example of these schools that justified the formation of the school boards now developed into the Local Education Authorities, which control elementary and, to a large extent, secondary education throughout the country. Also it was the Society's examinations that inaugurated the whole local examination system, which, whatever its deficiencies and its faults, has beyond question done much valuable work for the promotion of education in England.

For many years past an earnest effort has been made to secure the valuable aid of these important authorities, and much progress has been made. This year a great step in advance was made, when the Council succeeded in securing the aid of the London County Council Education Committee in the superintendence of the examinations.

The Society's examinations for the past fifty years have been conducted through the agency of voluntary committees, and it was felt that these committees could be relied upon for the strict supervision of the examinations. But, to quote a paragraph from the 1911 report of the Council, "the development and competition between the various proprietary institutions

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which have sprung up of late years, and which it may be added are doing very efficient service in the cause of education, has produced a source of temptation amongst those interested in such institutions, who are anxious to obtain all possible credit for their own schools, and may occasionally be led away to attempt to obtain such credit by illegitimate means." Small as are the temptations to such an illegitimate course, it is yet certain that the stress of competition has occasionally led to fraudulent proceedings. A few such in previous years have been detected and suppressed. Last year it was found necessary to take public action, and this action had the satisfactory result at all events of vindicating the Society's good faith.

But so long as the whole supervision of the examinations was in the hands of unofficial committees, who were of necessity associated with the institutions where the examinations are held, it could not be denied that even though, as was certainly the case, nearly all such committees were far above suspicion, the public could not be expected to place the same implicit reliance in the results of the examinations as if they were conducted under the supervision of some independent authority.

Negotiations were for some time carried on with the London County Council Education Committee, which is the education authority for the County of London, but it was not until after a good deal of inquiry and considerable discussion that the Committee saw their way to accede to the Society's request. Eventually they did so, and with most satisfactory results The final conclusion was not reached until a very short time before the date of the examinations this year, and consequently the arrangements were made under a certain amount of pressure. Nevertheless, they worked with perfect smoothness, and it may be said that they gave general satisfaction to all concerned. This, of course, is not to say that there were not a few complaints of individual hardship; but these were merely infrequent exceptions to the general satisfaction.

The actual changes in the administration were really not considerable, and in no way affected the candidates themselves. The various local committees were asked to send their applications to the L.C.C. Education Office, instead of to the office of the Society. The L.C.C., after inspecting the various centres, arranged which of these should be used for examination purposes and where candidates should sit for examination. All the larger schools were used as centres, and candidates from these schools sat where they were taught. The candidates from the smaller schools were distributed among adjacent centres, and a certain amount of administrative work was thus saved. The most important change really was that the superintendents for the examinations were appointed by the Committee, and were responsible to it, so that the examinations were for the first time in London conducted under the superintendence of independent officers unconnected with the institutions where the examinations were held. The necessary additional cost (£177) was this year borne by the Society's funds; but notice was given that for future years it would have to be provided by a small fee to be paid by the local committees. It was found that the cost of supervision worked out at just 1s. per candidate, and this amount it is now proposed to charge all the London centres, leaving it to the local committees to make their own arrangements for defraying it. It is difficult to see that any objection can be raised to this, because the local committees will in future be relieved from the cost of providing and paying their own superintendents.

If it is found possible in the future to reduce this charge, such reduction will certainly be made, as there is no desire to make any profit out of the charge. There can be no doubt of the value of the assistance rendered by the London County Council, or that its co-operation will add greatly to the value of the examinations, and to the public appreciation of the certificates awarded to the candidates. A similar co-operation has, of recent years, been arranged between the Society and a large proportion of the educational authorities throughout the country, who have established centres of their own, and have in many cases absorbed previously existing local committees. It is the earnest hope of the Council that this system, which has been steadily increasing during the past few years, may still further develop, and that, especially in the great provincial cities, the educational authorities will fall into line with the London County Council, so that, before long, the whole of the Society's examinations may be conducted under official and independent authority.

There is one important result accruing from the official supervision of the examinations, and that is that in London, and wherever the examinations are under such official supervision, the responsibility being taken away from the local committees, their duties are now confined to receiving the entries and collecting the fees from the candidates from their own centres

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It therefore follows that there is now no necessity for discrimination. Any teaching institution in London can now form its own committee, and can send in its candidates. If such candidates are sufficiently numerous they can be examined at their own centre. It is hoped that this may facilitate the admission of some candidates from institutions where examinations have not been previously held, or where, for whatever reason, they have been discontinued.

In the printed results of the examinations each school gets the credit of the passes of its own candidates, whether or not the school was used as an examination centre.

The examinations this year were held in the County of London and at 401 other centres in the week commencing March 25th, and lasted from the Monday until the following Friday. The results were issued at the following dates:—Advanced Stage, June 15th; Intermediate Stage, July 15th; Elementary Stage, August 15th. Having regard to the very large numbers of papers to be dealt with, no prospect can be held out of the results being issued at earlier dates.

The Commercial subjects included Book-keeping, Accounting and Banking, Shorthand, Typewriting, Economics, Précis-writing, Commercial Law, Commercial History and Geography, Arithmetic, Handwriting, Commercial Correspondence, etc., and Modern Languages. The other subject of examination was Music, divided into Rudiments of Music and Harmony.

The Society this year awarded twenty-six Silver and forty-two Bronze Medals, the former in the Advanced Stage, and the latter in the Intermediate. It also gave away money prizes to the value of £92, besides the prizes, amounting this year to £20—since some were not awarded—provided annually by the liberality of the Clothworkers' Company.

The number of centres at which the examinations are held has increased with the growth of the examinations, and of recent years in rather larger proportion than the number of candidates. As no actual return is made of the number of centres under the London County Council, it is not easy to state the exact number of centres where the examinations were held this year. The total may be taken as slightly over 500, of which 401 were outside London. Of these, 301 were in England and Wales, 46 in Scotland, 53 in Ireland, and one in the Channel Islands (Guernsey).

The total number of candidates at the examinations of 1912 was 28,057 (Advanced, 4,754; Intermediate, 11,855; Elementary, 11,448). This is a decrease of 587 upon the 28,644 candidates of 1911.

This is the first year in which a falling-off in the number of candidates has occurred since 1883, when the present system began. For thirty years the growth has been continuous, sometimes large and sometimes moderate, but there has always been a growth. That it has been interrupted is to be deplored, but the cause is quite certain. It is due to the fact that it was necessary last year to remove from the list of London centres one of the largest, from which of recent years over 2,000 candidates had been entered. But for this most unfortunate necessity, it may fairly be assumed that an increase at least equal to that of last year would have taken place in the number of London candidates. In the numbers examined at centres outside London, there is an actual increase this year, though it is not large enough to counterbalance the falling-off in London.

The decrease was shown in the Advanced and Intermediate Stages, and amounted to 380 in the former and 378 in the latter. In the Elementary Stage there was an increase of 171.

The number of papers worked by the candidates was:—Advanced, 5,483; Intermediate, including Theory of Music, 13,583; Elementary, 14,936, or 34,002 papers in all.

In addition to the 28,057 examined in the annual examination, there were 45 Shorthand candidates at the Special Army Examination, 633 candidates in Colloquial Modern Languages, and 296 in the Practice of Music. The total number of candidates who were examined in all subjects by the Royal Society of Arts during the year ending July last was, therefore, 29,031.

The general results of this year's examinations are given in Table A (page 1139), and a comparative view of the numbers examined during the last six years (1907–12) is given in Table B (page 1140). Table K (page 1143) gives the totals of the Commercial and other examinations for the same period; and Table G (page 1141) the numbers of papers worked.

In the Advanced Stage the falling-off in numbers due to the cause previously mentioned is felt in nearly all the subjects. In one only is there a considerable increase, namely Commercial Law—in this 380 papers were worked as compared with 247 last year, showing an increase of 133. In German there is a small increase of 12—224, as compared with 212. Typewriting and Economics just hold their own, there being an increase of two in the former subject and four in the latter. The largest falling-off is in French,

in which there were 793 papers as compared with 967, or a decrease of 174. Book-keeping shows a falling-off of 109—2,156, as compared with 2,265. In Shorthand there are 93 less than last year. Arithmetic shows a proportionately very heavy loss; last year there were 177, this year there are only 93—not much more than half the number. In English also there is a large proportionate loss—87 against 134, a falling-off of 47. Other subjects showing deficiencies are Commercial History and Geography, 23; Précis-writing, 22; Spanish, 8; Italian, 5; and Portuguese, 2.

With regard to the numbers in the various subjects of the Intermediate Stage, the same remark applies as in the case of the Advanced. Nearly all the subjects show a falling-off, with the important exception of Commercial Correspondence and Business Training, in which there is a large increase of 151, the total being 454 as compared with 303 in 1911, the first year in which this subject was introduced. English, French, and Spanish show small increases; all the others show a falling-off. The largest decrease, as might be expected, is Shorthand, in which there are 224 less. Book-keeping shows a diminution of 160, and Précis-writing a proportionately large falling-off of 124, there being only 144 candidates, whereas last year there were 268. The differences in other subjects are not very large, though the small number of candidates in Italian, 28 last year, is reduced this year to 12.

In Arithmetic, as previously noted, there was a considerable falling-off in the number of papers in the Advanced Stage. This was certainly not made up for by any considerable improvement in the quality of the papers, for the percentage of failures was greater than last year. On the other hand, the percentage of the first-class was slightly larger. It seems hardly worth while to repeat the fact which has so often been stated, that the large percentage of failures in this and in other subjects is due to the entering of candidates who are quite unable to deal with papers of this standard. The examiner remarks that the best papers show, as usual, a high degree of intelligence. In the Intermediate Stage the number of entries fell off slightly; the first-class percentage is nearly the same as in the last two years, the percentage of the second-class is greater, and that of the failures less. The examiner notes a distinct improvement in the style in which the papers were worked. In the Elementary Stage there was a large increase in the number of candidates, but not a proportionate number of passes. The examiner notes that, on the whole, there is an improvement in the style in which the work was done and in general neatness.

In English the percentages show an improvement upon last year, the failures being on the whole proportionately less and the proportion of first-class being greater. The examiner speaks well of the character of the work done both in the Advanced and in the Intermediate Stages.

In Book-keeping the percentage of first-classes in both the upper stages is certainly lower than it ought to be, and the percentage of failures greater. The results of the examination seem to be very similar to those of last year, and certainly do not show any improvement in the standard of the work. In this subject it is specially noticeable that candidates who ought to be content with a Stage II. certificate will unwisely enter themselves for Stage III. In the Elementary Stage it is satisfactory to note that there is evidence of a distinct improvement, as the work appears to be generally better, since with a very large increase—the total being 5,013 as against 4,601—the percentage of failures is a little lower than last year.

Commercial History and Geography in all stages shows an improvement, especially in the two higher stages. Here, again, candidates and teachers should read the examiner's remarks.

In Shorthand the Examiner expresses his regret that there has been very evident deterioration in the work of the candidates entering for Stage III., and attributes this result to the lack of sufficient general education in the candidates. There is a distinct falling-off in the number of first-class certificates, a falling-off which is certainly not attributable to any increased difficulty in the paper or to severity on the part of the examiner, for a careful examination of his results made it quite clear that it was impossible, without a lowering of the character of the examination, to give better marks to a larger proportion of the papers which were sent in. In the Intermediate Stage the results were rather better. The proportion of first-class papers was rather higher, and the proportion of failures rather lower than last year. In the Elementary Stage there was a decided improvement, for though the number of entries was larger, the percentage of passes shows an increase of nearly four.

In Typewriting there was a larger proportion of first-class papers in Stage III., but unfortunately there was also a larger proportion of

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failures. In Stage II., on the other hand, there was a falling-off in the first-class, a slight increase in the second, and a very distinct increase in the proportionate number of failures. The causes of these results are carefully discussed by the examiner in his report, to which teachers and candidates are referred. In the Elementary Stage, although there was a slight decrease in the number of papers, the percentage of passes shows an increase of 2 per cent.

In Economics both stages show an improvement. The proportion of successes has been greater, and the character of the work on the whole indicates advance.

As to the subject of Commercial Law, the examiner remarks that there was a striking increase from 247 to 380, or nearly 54 per cent., in the number of papers worked, and this was not accompanied by any decrease in the quality of the work. He adds that, speaking generally, the results of the examination are quite encouraging, as not only has the number of papers increased very considerably, but the number of failures has decreased, and the number of first-class certificates has nearly reached the normal standard of the years before 1911.

The results of the examination in Précis-writing are somewhat disappointing in both stages, and compare rather unfavourably with last year, although the papers set are believed to have been slightly easier.

As regards Accounting and Banking, the examiner says: "The number of candidates at the examination held this year was 476, as against 499 last year and 407 in 1910; showing a decrease of 23 as compared with last year. The percentages of candidates who passed are a little lower, and the percentage of failures a little higher, than last year. From the institution of this examination the results have been particularly satisfactory, the highest percentage of failures being only 32·12 (1907), while the average of the past seven years is 29·297; and it must be remembered that the standard is a high one. This points to the large majority of candidates having become well acquainted with the subject before presenting themselves for examination."

The results of the examination in Commercial Correspondence and Business Training, a subject in which an examination was held for the first time in 1911, are on the whole very satisfactory, both as regards the number of candidates and the character of the papers. The first-class papers were more numerous, though there was a slight increase in the percentage of failures. But this is not to be wondered at, considering the increase in the number of entries. At present this examination has only been held in the Intermediate Stage, but the results seem to justify the addition of an examination in the Advanced Stage after another year.

With regard to the corresponding subject in the Elementary Stage—Handwriting and Correspondence—the results this year show a distinct improvement upon last. With a slightly diminished number of entries, there was a definite increase in the passes. The examiner's report, on the whole, is favourable.

The examiner in French considers the character of the papers worked in all three stages satisfactory, and as not showing any very great difference from those of recent years. In the Advanced Stage the failures were about the same, and the number of first-class larger. In the Intermediate Stage the failures were rather larger, and the successes, both first and second-class, slightly smaller.

In German the examiner says that the papers in Stage III. were, as a whole, well done, and the results were most satisfactory. The essays were good, and the translations into German better than in previous years. Curiously enough, exactly the contrary result was noted as regards Stage II. In the Elementary Stage there was some improvement in the translations into German, but the standard is still, in the examiner's opinion, very low.

In Italian the numbers entering this year were smaller than usual, but the papers on the whole seem to have been better. The proportion of failures is less both in Stage III. and in Stage II., and the proportion of first-classes higher. The examiner speaks well of the translations into Italian.

In Spanish the results in the two higher stages were, on the whole, satisfactory. But in the Elementary Stage, although the paper was not a difficult one, it was not well done.

In Portuguese the results were, on the whole, a little better than last year.

There were a few candidates in Russian, Danish, Norwegian, Swedish, and Japanese; but none this year in Hindustani. It is proposed next year to add an examination in Arabic, as information has been received that a few candidates are ready to enter for it.

The examinations in Rudiments of Music and Harmony were carried on as usual at the same time as the Commercial examinations, and the results appeared as part of the results of the

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Intermediate Stage. The total number of candidates shows a trifling decrease on that of last year. This year there were 688, compared with 691 in 1911, 619 in 1910, 699 in 1909, 716 in 1908, 641 in 1907, and 637 in 1906. In Rudiments of Music, 391 candidates presented themselves, whereas last year there were 398. In Harmony there were 297, as compared with 293. Of the 391 candidates in Rudiments of Music, 306 passed and 85 failed. Of the candidates in Harmony, 203 passed and 94 failed. The examiner, on the whole, reports favourably on the results, which do not differ very much from those of recent years.

A report on the Practical Examinations in Music has been published in the *Journal*.* 296 candidates were examined—an increase of 13 as compared with the 283 last year; of these 220 passed and 76 failed. These examinations have been carried on continuously since they were established in 1879. The numbers for a long time did not vary very widely. In the first year 117 candidates were examined. The numbers increased gradually to 276 in 1891, and to 393 in 1895. The largest number yet examined was 566 in 1900. During the last few years there has been a small but steady diminution in the numbers. The standard has not varied much, but is now a little higher than it was. The general level of attainment is considered by the examiners to be about the same as for the last few years.

For the Viva Voce Examinations held this year in Modern Languages 633 candidates entered—an increase on last year, when there were 583. These examinations were started in 1902, when 280 candidates were examined. The numbers rose to 681 in 1905, after that there was a slight falling-off. Examinations were held this year in French, German, Spanish, and Italian; there have also in previous years been a few entries for Portuguese, but none entered during the last few years. The numbers were: French, 476; German, 123; Spanish, 22; Italian, 12. Table L (page 1143) gives in detail the results of this year's examinations.

The examiner in colloquial French reports that the examination was in no way below the level of its predecessors; there was an increase of 50 in the number of candidates examined, and the percentage of successes was higher. The German examiner says that the number of candidates examined was rather larger than in 1911, and the percentage of successes higher; he considers that the general results were extremely satisfactory. The results in Spanish are still rather unsatisfactory, though a little better than last year; the numbers entering were not so large, but the proportion of failures was smaller. Though the numbers entering in Italian is never very large, the candidates appear to be fairly well taught, and the proportion of failures is always very small.

At the request of the Army Council, the Council, in 1907, arranged to hold a special annual examination in Shorthand for soldiers, and such an examination has been held every year since. In 1907 there were 40 candidates; in 1908, 84; in 1909, 60; in 1910, 66; in 1911, 64. This year there were 45 entries. There were 25 centres in the United Kingdom, India, South Africa, and Malta. These examinations were held on February 15th. Of the 45 candidates, 31 passed and 14 failed. In the Advanced Stage there were 3 first-class and 5 second-class. In the Intermediate Stage there were 7 first and 16 second. The percentage of successes is about 69, which is not quite as good as last year, which was 73. Still this is much above the average of Shorthand examinations.

The Examination Programme for 1913 was issued two months ago. In it will be found the fullest possible information about the examinations, a syllabus of each stage of each subject, and the papers set in 1912.* The attention of both teachers and students may be drawn not only to the syllabuses but also to the remarks of the various examiners on the results of last year. It will be found that these contain many valuable and helpful suggestions, and the work of the candidates year after year shows that far too little attention is paid to them. Teachers especially are earnestly recommended to study these remarks, as they ought to be guided by them in the instruction they give to their pupils. The remarks of each examiner follow his examination paper in the Programme for each year, and have also been printed at the end of the published lists of results, in the hope—probably vain—that they may be read.

The regulations for the Examinations in Music (Theory and Practice), and those for the Viva Voce Examinations in Modern Languages, are also given at full length.

* See *Journal*, July 12th, 1912, Vol. LX. p. 815.

* The price of the Programme (133 pages) is 3*d*., post free 4½*d*. Copies can be obtained on application to the Secretary of the Royal Society of Arts, Adelphi, London, W.C. Programmes containing the papers set in 1905, 6, 7, 8, 9, 10, and 11 can also be obtained at the same price. The regulations and syllabuses can also be had separately (without the papers) price 1*d*., by post 1½*d*.

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TABLE A.—DETAILS OF THE 1912 EXAMINATIONS.

SUBJECTS.	STAGE III.—ADVANCED.				STAGE II.—INTERMEDIATE AND MUSIC.							STAGE I.—ELEMENTARY.			Total number of papers worked in all stages.
								Music Certificates.							
	Papers worked.	1st class certificates.	2nd class certificates.	Not passed.	Papers worked.	1st class certificates.	2nd class certificates.	Higher.	Inter-mediate.	Elemen-tary.	Not passed.	Papers worked.	Passed.	Not passed.	
Arithmetic	93	17	29	47	690	128	357	..	..	..	205	2,148	1,396	752	2,931
English	87	13	32	42	357	51	204	..	..	..	102	..	..	..	444
Book-keeping	2,156	89	1,008	1,059	4,127	375	2,372	..	..	..	1,380	5,013	3,113	1,900	11,296
Commercial History and Geography	24	3	12	9	60	11	33	..	..	..	16	..	..	..	84
Commercial Geography	..	..	..	..	..	..	..	..	..	..	..	313	178	135	313
Shorthand	774	67	236	471	4,120	909	2,256	..	..	..	955	2,860	2,130	730	7,754
Typewriting	224	63	88	73	885	188	397	..	..	..	300	1,227	827	400	2,336
Economics	59	6	38	15	91	26	51	..	..	..	14	..	..	..	150
Précis-writing	72	14	37	21	144	21	86	..	..	..	37	..	..	..	216
Commercial Correspondence and Business Training	..	..	..	..	454	43	255	..	..	..	156	..	..	..	454
Commercial Law	380	34	213	133	..	..	..	..	..	..	..	..	..	..	380
Accounting and Banking	476	83	257	136	..	..	..	..	..	..	..	..	..	..	476
French	793	144	474	175	1,497	115	1,007	..	..	..	375	1,110	708	402	3,400
German	224	62	92	70	332	54	146	..	..	..	132	412	213	199	968
Italian	20	11	7	2	12	6	4	..	..	..	2	21	18	3	53
Spanish	73	13	43	17	97	35	34	..	..	..	28	99	70	29	269
Portuguese	14	3	9	2	10	1	3	..	..	..	6	..	..	..	24
Russian	2	..	2	..	8	2	3	..	..	..	3	..	..	..	10
Danish and Norwegian	6	2	4	..	6	3	1	..	..	..	2	..	..	..	12
Swedish	6	2	1	3	..	..	..	..	..	..	..	..	..	..	6
Japanese	..	..	..	..	5	1	1	..	..	..	3	..	..	..	5
Handwriting and Correspondence	..	..	..	..	..	..	..	..	..	..	..	1,733	1,054	679	1,733
Rudiments of Music	..	..	..	..	391	..	..	197	..	109	85	..	..	..	391
Harmony	..	..	..	..	297	..	..	41	66	96	94	..	..	..	297
Totals	5,483	626	2,582	2,275	13,583	1,969	7,210	238	66	205	3,895	14,936	9,707	5,229	34,002

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TABLE B.—NUMBER OF PAPERS WORKED IN EACH SUBJECT OF STAGES III. AND II. IN 1907-8-9-10-11-12.

SUBJECTS.	1907.			1908.			1909.			1910.			1911.			1912.		
	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.	Stage III.—Advanced.	Stage II.—Intermediate.	Totals.
Arithmetic	107	446	553	98	544	642	139	653	792	148	638	786	177	731	908	93	690	783
English	60	262	322	60	293	353	74	349	423	91	341	432	134	351	485	87	357	444
Book-keeping	2,082	3,621	5,703	2,054	3,578	5,632	2,158	3,904	6,062	2,049	3,849	5,898	2,265	4,287	6,552	2,156	4,127	6,283
Commercial History and Geography	28	61	89	29	69	98	46	108	154	25	117	142	47	84	131	24	60	84
Shorthand	854	3,469	4,323	847	3,585	4,432	1,065	3,972	5,037	866	4,464	5,330	867	4,344	5,211	774	4,120	4,894
Typewriting	254	671	925	270	683	953	252	830	1,082	245	849	1,094	222	887	1,109	224	885	1,109
Economics	59	30	89	53	52	105	65	73	138	63	68	131	55	83	138	59	91	150
Précis-writing	72	132	204	50	102	152	62	107	169	63	129	192	94	268	362	72	144	216
Commercial Correspondence and Business Training	..	..	..	..	..	..	..	..	..	..	..	..	..	303	303	..	454	454
Commercial Law	238	..	238	214	..	214	216	..	216	237	..	237	247	..	247	380	..	380
Accounting and Banking	302	..	302	288	..	288	369	..	369	407	..	407	499	..	499	476	..	476
French	473	1,046	1,519	535	1,144	1,679	655	1,374	2,029	807	1,283	2,090	967	1,488	2,455	793	1,497	2,290
German	152	273	425	167	271	438	175	312	487	160	317	477	212	354	566	224	332	556
Italian	21	17	38	21	22	43	21	22	43	28	14	42	25	28	53	20	12	32
Spanish	91	106	197	77	104	181	89	90	179	82	121	203	81	90	171	73	97	170
Portuguese	15	4	19	22	12	34	26	8	34	25	13	38	16	16	32	14	10	24
Russian	3	9	12	2	6	8	4	9	13	2	9	11	4	6	10	2	8	10
Danish and Norwegian	4	8	12	6	3	9	9	..	9	7	4	11	10	5	15	6	6	12
Hindustani	..	..	..	..	1	1	..	..	..	..	..	..	2	3	5	..	..	..
Swedish	..	6	6	2	11	13	8	..	8	4	5	9	7	4	11	6	..	6
Japanese	..	..	..	..	3	3	..	..	..	..	1	1	..	2	2	..	5	5
Chinese	..	..	..	..	..	..	..	2	2	..	2	2	..	..	..	..	..	..
Totals	4,815	10,161	14,976	4,795	10,483	15,278	5,433	11,813	17,246	5,309	12,224	17,533	5,931	13,334	19,265	5,483	12,895	18,378

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TABLE C.

PERCENTAGES OF SUCCESSES AND FAILURES, ADVANCED STAGE, 1912.

	First-class.	Second-class.	Failures.
Arithmetic	18·29	31·19	50·52
English	14·95	36·78	48·27
Book-keeping	4·13	46·75	49·12
Commercial History and Geography	12·50	50·00	37·50
Shorthand	8·78	30·49	60·73
Typewriting	28·12	39·29	32·59
Economics	10·17	64·41	25·42
Précis-writing	19·44	51·39	29·17
Commercial Law	9·00	56·00	35·00
Accounting and Banking	17·44	54·00	28·56
French	18·16	59·77	22·07
German	27·68	41·07	31·25
Italian	55·00	35·00	10·00
Spanish	17·80	58·90	23·30
Portuguese	21·43	64·28	14·29
Russian	0·00	100·00	0·00
Danish and Norwegian	33·34	66·66	0·00
Swedish	33·34	16·66	50·00

TABLE D.

PERCENTAGES OF SUCCESSES AND FAILURES, INTERMEDIATE STAGE, 1912.

	First-class.	Second-class.	Failures.
Arithmetic	18·55	51·74	29·71
English	14·29	57·14	28·57
Book-keeping	9·08	57·48	33·44
Commercial History and Geography	18·34	55·00	26·66
Shorthand	22·07	54·75	23·18
Typewriting	21·24	44·75	34·01
Economics	28·57	56·05	15·38
Précis-writing	14·58	59·72	25·70
Commercial Correspondence and Business Training	9·47	56·17	34·36
French	7·68	67·27	25·05
German	16·26	43·98	39·76
Italian	50·00	33·33	16·67
Spanish	36·08	35·06	28·86
Portuguese	10·00	30·00	60·00
Russian	25·00	37·50	37·50
Danish and Norwegian	50·00	16·67	33·33
Japanese	20·00	20·00	60·00

TABLE E.

PERCENTAGES OF SUCCESSES AND FAILURES IN ALL STAGES, 1907-8-9-10-11-12.

	1907.	1908.	1909.	1910.	1911.	1912.
Advanced (Stage III.).						
First-class	15·00	12·99	12·60	12·60	11·64	11·42
Second-class	47·80	51·95	44·60	53·38	48·15	47·09
Failures	37·20	35·06	42·80	34·02	40·21	41·49
Intermediate (Stage II.).						
First-class	19·45	22·60	13·31	12·77	15·78	15·27
Second-class	50·25	50·40	53·75	52·47	56·00	55·91
Failures	30·30	27·00	32·94	34·76	28·22	28·82
Elementary (Stage I.).						
Passes	59·62	64·45	66·54	66·80	64·69	64·99
Failures	40·38	35·55	33·46	33·20	35·31	35·01

TABLE F.

ELEMENTARY EXAMINATIONS, STAGE I.

Year.	No. of candidates.	No. of papers worked.	No. of subjects.
1901	3,902	4,458	8
1902	4,371	4,807	8
1903	5,382	6,020	8
1904	6,401	7,203	9
1905	7,397	8,427	10
1906	7,425	8,537	10
1907	7,692	8,952	10
1908	8,276	9,811	10
1909	9,196	11,069	10
1910	10,289	12,720	10
1911	11,277	14,286	10
1912	11,448	14,936	10

TABLE G.

NUMBER OF PAPERS WORKED IN ALL STAGES, 1905-6-7-8-9-10-11-12.

	Stage III.	Stage II.	Stage I.	Total.
1905	4,844	10,533	8,427	23,804
1906	4,904	10,734	8,537	24,175
1907	4,815	10,802	8,952	24,569
1908	4,795	11,199	9,811	25,805
1909	5,433	12,512	11,069	29,014
1910	5,309	12,843	12,720	30,872
1911	5,931	14,025	14,286	34,242
1912	5,483	13,583	14,936	34,002

The numbers for Stage II. include the papers set in Music.

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TABLE H.

PERCENTAGES OF FAILURES IN ALL SUBJECTS, ADVANCED STAGE, 1907-8-9-10-11-12.

	1907.	1908.	1909.	1910.	1911.	1912.
Arithmetic	25·23	33·67	47·48	44·00	45·76	50·52
English	40·00	41·50	37·10	34·07	34·33	48·27
Book-keeping	32·04	33·93	41·43	36·40	45·21	49·12
Commercial History and Geography	32·14	37·93	50·06	44·00	51·10	37·50
Shorthand	62·18	45·70	73·90	38·11	60·32	60·73
Typewriting	31·10	23·70	29·76	59·59	24·78	32·59
Economics	30·51	32·07	24·62	31·75	45·46	25·42
Précis-writing	41·67	28·00	30·60	26·98	30·86	29·17
Commercial Law	30·45	43·00	33·80	39·24	45·35	35·00
Accounting and Banking	32·12	30·21	30·08	25·80	27·25	28·56
French	30·45	31·96	24·74	19·44	22·96	22·07
German	27·00	34·73	26·29	23·75	32·10	31·25
Italian	14·40	14·28	14·24	14·28	12·00	10·00
Spanish	35·15	27·27	29·00	45·12	35·80	23·30
Portuguese	0·00	0·00	0·00	16·00	25·00	14·29
Russian	0·00	0·00	0·00	0·00	0·00	0·00
Hindustani	..	..	..	..	0·00	..
Danish and Norwegian	25·00	16·66	11·00	14·28	30·00	0·00
Swedish	..	0·00	12·50	0·00	14·00	50·00

TABLE I.

PERCENTAGES OF FAILURES IN ALL SUBJECTS, INTERMEDIATE STAGE, 1907-8-9-10-11-12.

	1907.	1908.	1909.	1910.	1911.	1912.
Arithmetic	34·50	34·38	35·38	31·98	32·97	29·71
English	36·30	37·54	31·23	28·17	28·49	28·57
Book-keeping	27·34	23·31	30·74	30·76	32·63	33·44
Commercial History and Geography	50·80	33·33	33·30	29·06	36·91	26·66
Shorthand	27·70	26·15	36·64	43·06	25·27	23·18
Typewriting	31·59	22·26	31·59	32·27	28·07	34·01
Economics	26·67	30·77	27·40	19·12	16·87	15·38
Précis-writing	43·94	33·33	31·78	27·91	29·11	25·70
Commercial Correspondence and Business Training	..	..	..	..	31·68	34·36
French	29·64	20·00	29·33	26·58	22·45	25·05
German	35·53	35·00	46·15	32·49	21·47	39·76
Italian	23·55	13·00	18·00	14·29	17·86	16·67
Spanish	35·84	27·90	26·66	23·97	34·44	28·86
Portuguese	0·00	0·00	0·00	30·77	31·25	60·00
Russian	44·45	0·00	33·34	44·44	33·34	37·50
Danish and Norwegian	0·00	9·09	..	0·00	0·00	33·33
Swedish	83·33	0·00	..	20·00	75·00	..
Japanese	..	33·34	..	100·00	100·00	60·00
Hindustani	..	0·00	..	..	33·34	..
Chinese	..	..	0·00	0·00	..	..

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TABLE K.

CANDIDATES EXAMINED IN 1907-8-9-10-11-12.

	1907.	1908.	1909.	1910.	1911.	1912.
Commercial Knowledge—						
Stage III.—Advanced	4,279	4,283	4,770	4,654	5,134	4,754
Stage II.—Intermediate (including Theory of Music) . . .	9,752	10,038	11,076	11,340	12,233	11,855
Stage I.—Elementary	7,692	8,276	9,196	10,289	11,277	11,448
Totals	21,723	22,597	25,042	26,283	28,644	28,057
Music (Practice)	457	432	392	339	283	296
Colloquial Modern Languages . .	629	615	656	642	583	633
Army Candidates	40	89	65	66	64	45
Totals in all Subjects . .	22,849	23,733	26,155	27,330	29,574	29,031

TABLE L.

VIVA VOCE EXAMINATIONS HELD DURING 1912.

Place of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French :—	1912.				
Acton and Chiswick Polytechnic	March 15 .	30	8	10	12
Liverpool School of Commerce	April 19 .	30	7	18	5
Manchester Education Committee	April 30 .	19	2	12	5
Enfield Technical Institute	May 3 . .	36	9	23	4
Regent St. Polytechnic (Candidates from London Polytechnics)	May 17 .	30	12	10	8
Kensington College	May 21 .	24	13	10	1
City of London College (Candidates from London Polytechnics)	May 22 .	28	9	16	3
City of London College	May 23 .	23	6	12	5
Pitman's School (Candidates from London Polytechnics) . .	May 24 .	27	14	11	2
Birkbeck College	May 30 .	29	5	20	4
"Barnsbury Park" L.C.C. School	June 11, 12	42	17	21	4
L.C.C. Evening School, Sussex Road, Brixton	June 13 .	22	9	11	2
L.C.C. Evening School, Plough Road, Clapham Junction . .	June 14 .	23	8	9	6
L.C.C. Evening School, Choumert Road, Peckham	June 17, 18	40	10	21	9
Birkbeck College (L.C.C. Candidates)	June 19 .	23	11	11	1
Merchant Venturers' Technical College, Bristol	June 26 .	28	4	19	5
Birmingham, Municipal Technical School	July 4 . .	22	8	11	3
German :—					
Manchester Education Committee	May 8 . .	9	4	4	1
City of London College (Candidates from London Polytechnics)	May 20 .	27	8	13	6
Pitman's School (Candidates from London Polytechnics) . .	May 30 .	32	18	11	3
Birkbeck College (L.C.C. Candidates)	June 10, 20	33	6	13	14
Merchant Venturers' Technical College, Bristol	July 8 . .	22	..	13	9
Spanish :—					
Manchester Education Committee	May 2 . .	5	1	4	..
Pitman's School (Candidates from London Polytechnics) . .	June 3 . .	17	4	11	2
Italian :—					
Regent St. Polytechnic (Candidates from London Polytechnics)	June 10 .	12	3	6	3
Totals		633	196	320	117

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THE MOZAMBIQUE RUBBER INDUSTRY.

There is said to be no industry in Portuguese East Africa with a brighter prospect than that of rubber exploitation. The rubber forests are extensive, and the landolphia vines from which the rubber is extracted are profuse. With organisation and working capital there is no reason why the export of rubber should not shortly increase to 500 tons annually, while the percentage of rubber to waste in the vines is small as compared, for instance, with the output of latex from a young Ceara tree, the abundance of the vine and its remarkable powers of recuperation are factors which more than make up for the low percentage. There are at present in use two native methods of extracting rubber. The first, that of incision or tapping, is followed by all natives south of the Zambesi Valley, and it produces a high-class rubber known as "Mozambique pink," second only, according to the United States Consul at Lourenço Marques, to the best Para on the European market. The other method of extraction, known as pounding, is generally followed in the Mozambique and other northern districts. There the bark is stripped from the roots of the vines, or from the vines, and is cooked over a slow fire and pounded until the bark is finally pounded out, leaving a mass of rubber in all stages of crudity. This rubber is known as Mozambique rooty. It is classed very low, but a large concern now working in the Mozambique district has perfected the system of pounding to the point of producing a rubber which is rapidly approaching the classification of Mozambique pink. A strange truth has come to light in regard to the landolphia, and that is that while vines are frequently killed by incision or tapping, this seldom happens with the vine which is cut down almost to the ground after maturity. It is also a notable fact that large parts of the root of a vine can be dug up and cut off without killing the vine. In the Mozambique district there are places where natives have been cutting roots from the same vines year after year. The recognition of this fact will make an enormous difference in the estimates of the capacity of the forests. Most of the rubber areas in the province are well known, and up to a year ago they were all in the hands of the Government. The promulgation of the law of September 2nd, 1909, gave an impetus to private enterprise, and since the law came into force large districts have been taken up, and final title has been ceded by the Government on approximately 450,000 acres of forest. These large tracts are being worked mostly on a small scale, owing to lack of capital, and some are not being worked at all.

In the terms of the land law referred to above, it is most difficult, if not impossible, for a foreign capitalist to acquire directly a tract large enough to give returns on a big investment, say 50,000 hectares (123,000 acres). Such a grant would be subjected to the approval of the provincial council, the Governor-General, and the home government, and would finally come up for auction. However, various local groups of Portuguese, with the ten years' residence in Portuguese colonies prescribed by the said law as a condition to privilege, have established their claims, and combined their lots of 10,000 hectares (24,600 acres) to each individual, in large tracts of from 40,000 hectares (98,400 acres) to 100,000 hectares (246,000 acres) in extent. The rubber industry in Portuguese East Africa is not for the moneyless settler, however industrious. It offers big returns to the capitalist, by reason of the fact that he can work on a large scale. A concessionaire of say 50,000 hectares (123,000 acres) must split up his lands into five or six districts. Each district has a collecting station and a store, for the native has little idea of cash. When he has worked he must be paid in goods.

With the installation of machinery the semi-skilled labour of the native becomes less and less necessary. In a well-equipped concern his share in the production of rubber will be summed up in the simple work of gathering the bark of roots and vine. This can be done equally well by African or coolie. During 1910, rubber to the value of £75,000 was exported from the province of Mozambique, and this dropped to £42,500 in 1911. The great decrease in this important item can be traced to two causes—the break of the rubber boom and consequent collapse in prices, and the disturbed conditions which forced a duly organised rubber concern in the province to suspend operations during six months. The break in prices is by far the more important factor.

THE MOTHER-OF-PEARL INDUSTRY IN BETHLEHEM.

The chief industry to-day in Bethlehem is the manufacture of articles of religious devotion and ornaments from mother-of-pearl. The methods and tools used are mostly quite primitive in character, as are also the buildings in which the workmen carry on their trade. The principal products are carved shells, on which religious scenes are depicted, beads, and rosaries. The material known as "pearl waste," from which beads and rosaries are made, is very largely imported from the United States, and the American market is also the largest purchaser of these goods. In the manufacture of beads, which is now the most important branch of the industry, a workman's outfit is primitive, consisting of files, borers, and a simple wooden device for holding the irregularly shaped pieces of pearl waste. The American Consul at Jerusalem says that this last is made of a short, round piece of wood, sawn in half lengthwise, fastened together at one end, and encircled by a loose iron ring. The piece of pearl shell is placed between the loose wooden ends, and the ring is hammered toward it until the grip is tight. The workman then files the part of shell which extends to the desired diameter, it is reversed in the holder, and finally a rounded piece of perhaps one to three inches in length is secured. When

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a number of these pieces have been prepared they are cut to bead size, a hole is bored in each bead, and it is rounded to the desired shape. Then to give the beads a smooth surface, they are placed in special crockery vessels with a little water, and are kept in motion in these vessels, rubbing against the sides and each other until they are smooth, but not polished. To give them a gloss and sheen, they are finally placed in boiling water, to which a weak solution of nitric or muriatic acid is added, and when removed from this they are passed through a succession of cooling waters. There are three usual shapes—those flat on two sides, round, and oval. The beads are strung on cords, silk or wire, and always on the latter in the case of rosaries. For these last also crosses and hearts are made of mother-of-pearl, with a small metal figure attached to the cross. Silver crosses and hearts are used to a slight extent. The wages of the bead workmen are not high. Those who make the beads earn from 1*s*. 4*d*. to 2*s*. 8*d*. per day. The women and girls who string them receive from 6*d*. to 1*s*. per day. The files used are mostly of German and Belgian manufacture, with some of English make. With the exception of those employed for the finest work, which are imported new, old files are brought in and recut in Bethlehem. Formerly this was done by hand, but a machine has recently been secured from Europe for resharpening the old files. It is claimed that these resharpened files yield better results than new ones, and they are much less expensive. The borers are made locally from steel rods, especially imported for the purpose. The white-metal wire, for the rosaries and the silver accessories, is chiefly of French manufacture.

THE SPANISH MELON INDUSTRY.

The fame of the fine winter melons grown in the Valencia district, of which 12,000 to 15,000 are exported annually, has extended over the greater part of Europe. Classified in the order of harvesting season of each variety, the following are the principal species of melon cultivated: "Pudents" are the earliest in season, but have little else to recommend them, as they are considered insipid, and, as their name indicates (*pudrir*, to rot), decay quickly in handling and transportation. "Chincholats," or "Escrits," so called from the fanciful resemblance of the lines on the surface of the skin to Arabic writing, are small in size and of spherical shape. They are shipped in small quantities to the United Kingdom, where they bring fair prices because of their early appearance on the market (from the end of May to the end of June), but their flavour is said to be inferior, and the trade in them is precarious, as, if picked when too nearly ripe, they are very likely to decay in transportation. "Canarios," so named from their bright canary colour, are a hardy variety, which form the basis of Valencia melon exports to northern Europe in July and August. They are oval in shape, with tough rind and firm pulp, the layer of which, however, is not thick, as the seed cavity is disproportionately large. They withstand the sea voyage remarkably well, but are not distinguished by fine flavour. "Negros" and "bronceados" (black and bronze coloured), the genuine winter melons of the Valencia district, are by far the best varieties, and receive the greatest care in selection and cultivation. The former are of a dark, unchanging green colour, of an elongated oval or cylindrical shape, and unusually large, weighing from nine to sixteen pounds. The "bronceados" are oval, or slightly conical in shape, with thick pulp and small seed cavity. Both these varieties at their best are very fine, and probably nothing superior of their kind can be produced in any part of the world. The Valencia system of melon-growing requires seed beds and transplanting, according to the American Consul there. The seeds are planted in the beds in clusters of five or six on a layer of animal manure wrought into a thick paste by the addition of water, each cluster being deposited in slight depressions in the surface about eight or nine inches apart. The bed is then covered with a light sprinkling of dry pulverised manure, which is kept moist by occasional spraying with water. Transplanting takes place when the two lateral branches of the plant are thrown out and the tip of the central growth is just appearing. The more delicate plants are discarded, and only the healthiest and most vigorous utilised. In the Alicante district, a little south of Valencia, seed is planted definitely in the open, in pits about a yard apart, in which organic manure has been mixed with the soil. Water melons are harvested in the early autumn, and are suspended in loops of esparto cordage from nails in the beams of roofs and lofts, where they keep, with but little deterioration, for six months or more. The water-melon of the Valencia district and, indeed, of all Spain, appears to be a fixed species that has undergone little modification for centuries. The varying degrees of colour and different percentages of sugar that distinguish the pulp of fruit grown in different localities in Spain, appear to depend almost entirely on soil conditions rather than varieties, and the Valencia water-melon differs little from similar fruit grown in northern Africa. It does not attain very great size, but has a remarkably thin rind and highly-coloured meat, and is of superior quality. The principal pests from which water-melons of all kinds suffer in Spain are mildew, scale and snails. The scale, which is said to belong to the family of the rose scale, is the most difficult to combat successfully, especially when dull, foggy, warm weather conditions favour its rapid propagation. The dry, parching winds that blow at irregular intervals during the summer from the semi-arid interior of the country effectively arrest the progress of this scale, and, if continued two or three days, will exterminate it altogether. Snails are dealt with in a practical and economical way by turning flocks of ducklings into the melon plantations.

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ENGINEERING NOTES.

Communication between India and Ceylon.—"Quos Deus vult perdere prius dementat." This well-known maxim of dubious latinity, and unknown classical parentage, of which, by the way, there is a parallel in the common phrase "mess of pottage," which is not to be found in any part of the Bible, is brought to mind by circumstances which have led to the recent launch of the first of three geared-turbine steamers which are to convey passengers and goods across the narrow strait between India and Ceylon. The steam service will connect the railways of each country, pending the construction of a bridge or causeway, which is almost a certainty of the future. The main-line railways of the two countries are of the same gauge, 5 feet 6 inches. But, with full knowledge of the future possibility of a bridge, or at least the establishment of what is known as a train ferry—viz., a service of steamers, which would carry trains bodily across, such as are in use in many parts of the world—the Indian authorities adopted a 3 feet 3⅜ inches gauge for the railway leading to the ferry. This renders nugatory either of the above possibilities. Colombo, in Ceylon, is one of the finest ports of the world, large expenditure having been made upon it, while the coasts of Southern India are remarkably deficient in good harbours, so that, if the gauge had not been broken, an uninterrupted channel for the export of all Southern India produce would have been provided at the Ceylon port. As matters stand, three unnecessary transhipments will be the result, from the wide gauge to the narrow gauge, to the steamer on the Indian side, and from the steamer to the train on the Ceylon side, the cost of which will probably be equal to something like a hundred miles of extra rail carriage, and may amount to vastly more than the extra interest on the capital which might have been required for the wider line, especially in a flat country like Southern India. This is written under the heading of an engineering note, but the ineptitude which has led to the diversity of gauges in railways, destined ultimately to be connected, in India, Africa, and Australia, has been largely due to politicians, who have disregarded the counsels of their engineering advisers.

The Ghent Exhibition.—Machinery is to be the special feature of the Ghent Exhibition to be held next year. The buildings will cover fifty acres more ground than those at Brussels. France has taken fifty per cent. more space than at the latter Exhibition. For the first time abroad, the British machinery exhibits will be collective in character, following foreign precedent, and the Machine, Tool and Engineering Association, as at Olympia, will be the means of carrying out this principle. The machinery hall will measure 19,000 square metres, and the railway gallery will have nearly 6,000 square metres. These areas are considerably larger than were devoted to engineering exhibits at Brussels.

Corrugated Ships.—The application of corrugation to the sides of ships was described at the Royal United Service Institution, on October 16th. This is not a mere proposal, for the principle has been tried in actual practice, four vessels so built having been launched, while two more are on the stocks. Captain MacIlwaine, R.N., who introduced the subject, claimed that a vessel of this kind was stronger than the plain ship, that she was steadier at sea, and that her stability was greater, that vibration was much reduced, and that she was faster for the same horse-power, or more economical in fuel for the same speed; also, that she would stand collisions of all sorts better. The corrugated ship differs from the plain one, in that she has two corrugations, or projections, running in a fore and aft direction, below the load line. From the top of the upper corrugation to the bottom of the lower is 13 feet 3 inches, and the groove between might be said to be of similar dimensions to the corrugations. From the inner edges of the frames the corrugations project 22 inches, they taper fore and aft until they merge into the normal form of the ship's ends. But Captain MacIlwaine explained that it was not to be understood that any sort of corrugations would suit any ship, or that no more than two would be carried; experiments were necessary until the most suitable form was discovered. Judging from this description of the lecturer, it would at first appear that much additional skin friction would be introduced, but this would seem to be more than compensated for by the lead which the corrugations give to the propeller, increasing its effectiveness, for it is stated that, taking the figures for different voyages, an average slip of 2 per cent. in fairly fine weather could be justifiably claimed. In plain ships of the same class and build as the corrugated ship, it was assumed that a fair average slip would be about 13 per cent.; this meant a saving of a very considerable amount of fuel. The principle does not appear to have been tried with twin-screw ships.

Electric Steel Works.—The Stobie Steel Company, of Sheffield, are erecting new works on Tyneside for the installation of electric steel melting furnaces, this site having been selected as current can be obtained on the north-east coast under more favourable conditions than in Sheffield. The works will at first consist of a 15-ton three-phase steel melting furnace, a 5-ton two-phase furnace for special steels, and a 3-cwt. alloy-melting furnace. A very fine installation of this description has been recently erected at Ugine, in Savoy; there they have the advantage of abundance of water-power. The current is received at 20,000 volts, and is transformed down to 65 volts. There is a full description of the latter works in "La Technique Moderne," of Paris, Vol. IV., 1912.

The Water-cooled Blast Furnace.—Thin-lined furnaces, cooled by a film of water, in place of the ordinary solid brick lining, were tried some

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years ago at the Gelsenkerchen works in Germany. Since then, they have been adopted in several places in the United States, notably by the Carnegie Steel Company and the Illinois Steel Company, and more recently in the works of the Tennessee Coal, Iron, and Steel Rail Company, and of the Detroit Iron and Steel Company. They are claimed to show a distinct superiority over the thick-lined furnace in operation, and their establishment in so many centres seems to justify the statement.

Dynamometer Car for Japan.—A dynamometer car is being constructed in the United States for the Japanese Government. It is 48 feet long by 8 feet 6 inches in width, and is of the hydraulic dynamometer type. It is capable of measuring traction up to 80,000 lbs., also recording speed, time, distance, vibration, and buffer thrust. Its maximum speed is eighty-five miles per hour. There is an axle generator and storage battery to supply current for operating the recording apparatus, and for lighting. There are vacuum brakes, and the journals, wheels, and equipment generally correspond to that of the Japanese rolling-stock. It is significant that the car, though built for 3 feet 6 inches gauge, is specified to be so constructed that it can be altered to suit the 4 feet 8½ inches gauge if necessary.

The Leicester, Derby, and Nottingham Water Supply.—The first instalment of these works, which will utilise the waters of the Howden and Derwent Rivers, was recently opened. The Howden dam, which has now been put into service, is 1,080 feet long by 117 feet high, and is 176 feet wide at the base, built of solid masonry. At one place it was necessary to excavate to the great depth of 172 feet to reach a water-tight bed. When the whole scheme is complete, there will be a supply of 33,000,000 gallons of pure water daily. The cost is estimated at £6,645,000.

Panama Canal Electric Power.—Those who are familiar with the plan of the canal will remember that the level of the artificial lake, which will be held up by the Gatun dam, will be 85 feet above sea-level, and locks at each end of the raised water will enable the ships using the canal to ascend from, and descend to, the ocean level. This lift in the traffic was rendered necessary to diminish the amount of cutting in the hills forming the backbone of the isthmus. Advantage is to be taken of the head of water at the locks at the Atlantic end to erect an electrical power-station, in order to supply the power requirements of the canal itself and electrical energy generally for the canal zone. The turbo-generators will be of the vertical type, and the rotating element will be suspended from an over-hung thrust-bearing, supported by the top shield of the generator. The turbine will be set in a heavy masonry foundation, and the generator will be super-imposed upon the turbine casting. Each turbine is rated at 2,250 kilowatts, at a speed of 250 revolutions per minute, and will consume, approximately, 500 cubic feet of water per second at full load. The generator is to be rated at 2,000 kilowatts, and will deliver three-phase 25-cycle current at a potential of 2,200 volts. A high voltage transmission line will connect the station with the existing steam generating stations at Miraflores, which will be held in reserve.

GENERAL NOTES.

International Building Trade Exhibition, Leipzig, 1913.—An International Building Trade Exhibition (with special exhibitions) will be held at Leipzig from May to October, 1913. The Exhibition has for its object to give a comprehensive survey of the progress made in matters concerning public buildings and dwellings in all civilised countries. As the building trade will be represented in all its branches, great value is attached to the greatest possible clearness of arrangement and systematic division of the material. To ensure this a special department for science and art in a separate building will be constructed, which will allow of arranging the exhibits according to the material instead of the exhibitor. In this building the most prominent masterpieces of architecture will be illustrated by models, drawings, photographs and memoirs, arranged systematically in groups, which will bear suitable references to the stands in the remaining exhibition buildings where are exhibited the respective products of the industry.

Fire-proof Roofing.—A cheap and durable fire-proof roofing is made in France with asbestos and Portland cement, in the proportion of one-fifth of asbestos fibre, one-fifth asbestos powder, and three-fifths Portland cement. The mortar, which must be carefully mixed, is pressed into wooden moulds about two feet square and one-fifth of an inch thick with the trowel. These slabs, when perfectly set, are used in the same way as slates and nailed to the woodwork of the roof. This kind of roofing, which is very light and durable, is suitable for sheds and out-buildings.

Production of Petroleum in Rumania.—The production of petroleum in Rumania during the first six months of the present year amounted to 861,901 tons, as compared with 690,353 tons for the corresponding period of 1911, showing an increase of 171,548 tons, or nearly 25 per cent. for this year. The output would have been considerably greater but for serious fires which occurred in the oil-fields of Moreni-Stravopoleos and Moreni-Bana, when considerable losses were incurred from this cause. Fires are of frequent occurrence at borings where the oil rises to the surface, in spite of the care displayed by the companies in order to prevent them. Great improvements have been made of late years in the working of the oil-fields in Rumania.

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CATTLE-BREEDING IN BRAZIL.—The Brazilian Government, being particularly anxious to encourage cattle-breeding in Brazil, has taken measures to establish stud and model breeding farms in the pastoral districts. The object of these farms is the theoretical and practical study of all questions relating to cattle-breeding and the improvement of the various stocks. The stud farm at Pinheiro in the State of Rio de Janeiro has already been installed, while those at Ribeirao Preto in the State of Sao Paulo, and at Lages in the State of Santa Catharina, are in course of construction. Two establishments that will give special attention to the improvement of the native species of cattle, and to the breeding of a type of horse which will serve for remounts for the army, have already been opened, one in the State of Parana, and the other in the State of Rio de Janeiro, while a third is shortly to be opened at Urberaba in the State of Minas Geraes.

EXHIBITION OF AUTO-CARS AND MOTOR MACHINERY AT BRUSSELS, 1913.—An important exhibition of auto-cars and motor machinery is announced to be held at Brussels next year under the auspices of "La chambre Syndicale de l'automobile et du Cycle de la Belgique." A considerable space will be reserved for agricultural machinery as applied to "moto-culture," both at home and in the colonies. The exhibition will take place from January 11th to January 22nd, 1913.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 18...British Architects, Institute of, 9, Conduit-street, W., 8 p.m. Mr. J. L. Ball, "Bath and Wells."

Sanitary Engineers, Institute of, Caxton Hall, Westminster, S.W., 8 p.m. Mr. E. van Putten, "Intercepting Traps in House Drains."

TUESDAY, NOVEMBER 19...Statistical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Dr. Dudfield, "Still-Births in Relation to Infantile Mortality."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. 1. Mr. L. Gaster (Hon. Secretary) will present a report of progress during the vacation with special reference to his visits to the Continent and to the United States. 2. Mr. J. W. Johnston, "Ancient Forms of Lamps." 3. Mr. H. T. Harrison, "A New Illumination Photometer." 4. Mr. W. C. Clinton, "Some Simple Colour Boxes." 5. Messrs. J. S. Dow and V. K. Mackinney, "Photography in Illuminating Engineering." 6. "Miner's Lamps."

Civil Engineers, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Discussion on papers by Mr. B. H. Blyth, jun., "The Construction of the New Dock at Methil," and Mr. W. Cleaver, "Alterations and Improvements of the Port Talbot Docks and Railway during the Last Decade."

WEDNESDAY, NOVEMBER 20...ROYAL SOCIETY OF ARTS. John-street, Adelphi, W.C., 8 p.m. Inaugural Address of the 159th Session, by Lord Sanderson, Vice-President and Chairman of the Council.

Meteorological Society, at the Surveyors' Institution, Great George-street, S.W. 7.30 p.m. 1. Dr. H. R. Mill, "The Unprecedented East Anglian Rainfall of August 26th, 1912." 2. Mr. A. P. Jenkin, "A Three-year Period in Rainfall."

Geological Society, Burlington House, W., 8 p.m.

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Rev. Hilderic Friend, "British Euchytraeids. IV.—The Genus Henlea." 2. Messrs. E. Heron-Allen and Arthur Earland, "Saccammina Psammosphœra (North Sea No. 2)."

United Service Institution, Whitehall, S.W., 3 p.m. Professor C. W. C. Oman, "Courts-Martial of the Peninsular Army, 1809–1814."

THURSDAY, NOVEMBER 21...Mining and Metallurgy, at the Geological Society, Burlington House, W., 8 p.m.

Ophthalmic Opticians, Institute of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 8 p.m. 1. Dr. A. B. Rendle, "Mr. P. A. Talbot's collection of plants from Southern Nigeria, illustrated with lantern-slides." 2. Mrs. Longstaff, "Impressions of the feeding tracks of *Limax maximus* and *Helix aspersa.*" 3. The Rev. G. Henslow, "Vegetable Mechanics." 4. Miss Nellie Bancroft, "Some Indian Jurassic Gymnosperms."

Chemical Society, Burlington House, W., 8.30 p.m. 1. Messrs. H. B. Baker and M. Baker, "The Change in the Boiling Points of the Trioxide and Tetroxide of Nitrogen on Drying." 2. Mr. E. Feilmann, "The Tendency of Atomic Weights to approximate to Integral and Semi-integral Values." 3. Messrs. F. B. Power and H. Browning, jun., "The Constituents of Taraxacum Root." 4. Messrs. S. A. Brazier and H. McCombie, "The Condensation of α-keto-β-anilino-$\alpha\beta$-diphenylethane and its Homologues with Phenyl Carbimide and Phenyl Thiocarbimide." 5. Messrs. G. Senter and F. Bulle, "Neutral Salt Action. Part II.—The Influence of Sodium Salts of Organic Acids on the Rate of Hydrolysis by Alkali." 6. Mr. O. L. Brady, "The Constitution of Aconitine." (Preliminary Note.)

Historical, 7, South-square, Gray's Inn, W.C., 5 p.m. Mr. E. Beck, "The Crutched Friars."

Numismatic Society, 22, Albemarle-street, W., 6.30 p.m.

FRIDAY, NOVEMBER 22...Fine Art Guild, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.15 p.m. Mr. Carl Henschel, "The Sun as an Engraver."

Physical Society, at the Imperial College of Science, South Kensington, S.W., 5 p.m.

Mechanical Engineers, Storey's-gate, Westminster, S.W., 8 p.m. 1. Mr. J. W. Anderson, "Vapour-Compression Refrigerating Machines." 2. Dr. J. H. Grindley, "A Contribution to the Theory of Refrigerating Machines."

Correction.—With reference to the statement in an article on "Soya Bean Production in Manchuria," which appeared in the *Journal* of August 16th last (page 902), that "the United States have shown their appreciation of the bean by abolishing the import duty," Messrs. Bigland, Sons, and Jeffreys write to say that they have made inquiries at Washington, and are advised that the duty on soya beans into America still remains at 45 cents per bushel, and is not likely to be removed. The statement in the *Journal* was made on the authority of a resumé of a report of the Chamber of Commerce of Trieste. The Editor regrets that it is incorrect, and desires to thank Messrs. Bigland, Sons, and Jeffreys for drawing his attention to the matter.

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No. 3130. VOL. LX. NOV. 15, 1912.

Published every Friday

JOURNAL of the ROYAL SOCIETY OF ARTS

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price to non-members 6d.

LONDON PUBLISHED FOR THE SOCIETY BY GEORGE BELL & SONS, LTD. YORK HOUSE, PORTUGAL ST. W.C.

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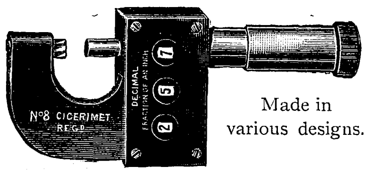

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